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ABSTRACT

At the eighth Western Regional Conference on Testing Problems, the following speeches were given: (1) "Background for Recent Curriculum Developments" by Ralph W. Tyler; (2) "Recent Curriculum Developments in Mathematics" by Robert E. K. Rourke; (3) "Recent Curriculum Developments in Science" by Kenneth E. Davis; (4) "Changes in Measurement as a Result of Curriculum Developments" by S. A. Kendrick; and (5) "Judging the Usefulness of a Test in Curriculum Measurement" by Robert L. Ebel. A list of conference participants concludes the report. (KM)

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EDUCATIONAL TESTING SERVICE

Eighth Annual
Western Regional Conference
on Testing Problems
1959

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The Eighth Annual

WESTERN REGIONAL CONFERENCE
ON
TESTING PROBLEMS

Measurement Implications of Recent Curriculum Developments

May 1, 1959
Hollywood Roosevelt Hotel
Los Angeles, California

Dr. Arthur P. Coladarci, Chairman

EDUCATIONAL TESTING SERVICE
Princeton, New Jersey Los Angeles, California

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The Eighth Annual

WESTERN REGIONAL CONFERENCE ON TESTING PROBLEMS

The morning meeting of the Eighth Annual Western Regional Conference on Testing Problems, held in the Blossom Room, Hollywood Roosevelt Hotel, Los Angeles, California, convened at 9:30 a.m., Dr. Arthur P. Coladarci, General Chairman, presiding. Dr. John S. Helmick, Director of the Los Angeles Office of Educational Testing Service, welcomed the conferees.

DR. JOHN HELMICK: I am beginning to feel like an old timer at this. This is my third opportunity to introduce an Annual Western Regional Conference on Testing Problems. This is the eighth such conference, however, so I'm still really a relative newcomer.

We appreciate your continued support. Every year we have had not only a bigger conference, but I think each succeeding year we have had a better conference. We appreciate your suggestions as to how these annual meetings may be improved so that they will be more useful to you. We frequently get contradictory suggestions, so it's not possible to please everybody; but we will endeavor to do the best we can.

Since this is the last time I will be before you today, I want to take this opportunity to thank the participants in advance, not that I feel it wouldn't be appropriate to thank them afterwards, but I'm not going to be around to do it. The cooperation they provide is absolutely essential, of course, to a conference such as this. This is particularly so since their contribution to measurement is essentially their only reward. We appreciate very much their willingness to help.

Most of the members of the staff of the Los Angeles office of the Educational Testing Service have been involved in some way in the preparation and planning for this conference. My own role has been a most minimal one. Primarily, it consists of having the opportunity to thank all these people for their help, particularly Robert Lambert, who is in charge of our Advisory Services, and as such has had general responsibility for the conference. I also wish to thank Mrs. Mary Owen, who has handled the many arduous details of the necessary arrangements. Without them, it is clear we would have had no conference.

My only other task is to introduce the General Chairman to you. As is so often the case, most of you do not need this introduction. Nevertheless, I have some information; and before I sit down, I'm going to tell you a little bit about him for the sake of those few who may not be familiar with him. He is Professor of Education and Psychology at Stanford University. His origins were in Connecticut. He went to school there, obtained his Ph.D. at Yale University, with some additional graduate studies at New York University and Johns Hopkins. He taught in the Danbury Public Schools, at the University of Connecticut, and New Haven State Teachers College. He began the western migration with a stopover at the University of Indiana. As I have indicated, he has ended up, as so many good people do, at Stanford.

He has been a consulting editor for the Dryden Press and is now serving in that capacity for the John Wiley Press. Among his unique activities has been a year as a senior Fullbright research scholar in Japan. Apparently, he is in the process of becoming a Japanese expert, for in September, he will be a delegate to the International Conference on Educational Research in Tokyo. As many of you know, he has authored many books and articles in the field of educational psychology, educational research, and educational criticism. I am very happy now to turn the rest of the meeting over to Dr. Arthur Coladarci of Stanford University, who is General Chairman of the conference.

GENERAL CHAIRMAN ARTHUR P. COLADARCI: Thank you, Dr. Helmick. A few years ago, the people then directing the Western region for ETS circulated a questionnaire among participants at one of their conferences, asking for criticisms of it. I find it very difficult to resist an invitation of this sort; and since negative criticism is easy to give, I did precisely that. I don't remember what I said, except it was negative. One of the consequences of that was the invitation to act as Chairman today. This is a form of co-optation.

Fortunately, this conference appears to be the best that the ETS people have ever planned. I say this not because of the chairmanship, but because of the people who are going to speak, as well as the kind of people who are here in the audience - a very distinguished looking group, of whom I know none. I see some faithful graduate students of mine and some even more faithful persons yet in training, the most faithful kind of all. It is on these bases that I feel we are going to have a very comfortable day.

We have a tight schedule because at least one of our speakers, Mr. Rourke, insists on using all the time assigned to him. Therefore, I have really no time in which to say anything important.

Let me briefly note that the general plan for today is to have three speakers on the general curriculum patterns that are now emerging and problems involved in them. This afternoon, Mr. Kendrick and Mr. Ebel will speak to the question of what implications flow for the psychometric task from the present status of affairs in curriculum. This means education generally. I don't think there is any intention to focus on any one level. It happens, largely by accident, that most of the speakers will be representing the secondary and higher education fields. Their intent, however, is to speak to the general problem, not to the specific educational level they represent.

After each speaker, you will have an opportunity to get rid of your own aggressions, hostilities, and anxieties in the form of questions. These are earnestly solicited. You are warned to do only one thing, that is to identify yourself very clearly by name and origin so far as it represents your current address. You may resist any evaluations of it if you wish. You must say this clearly, because the proceedings will identify you by name. It is embarrassing to say something brilliant and find it attributed to somebody else. The converse is comforting, but you can't predict it.

I have a couple of generalizations which I think are relevant to the theme of today's session as well as to the content of each of the five papers and the remarks you will hear. We have often told ourselves (and I think we mean it) that developments in testing have far outreached our ability to use them intelligently. I think this is true. We continue to be unintelligent with the procedures we have and very frequently complain that the procedures are not up to the task in which we are engaged. What is distressing, however, is that very frequently, tasks in which we are engaged are without rationale; so psychometric questions can't really be raised intelligently. It is for this reason that I am particularly interested in hearing the first three papers, which are addressed to the question of what curriculum situation confronts us, from which one presumably raises psychometric questions.

There are, in education, many viewpoints regarding tests. If somebody rotates an axis through them, he would come out, I suppose, nauseous. There is, for instance, a large group, which I identify as the sentimentalists, who feel that if you administer a test, you "don't really find out about the child". This group, which is well entrenched in high places sometimes, makes statements such as these. These are actual quotations. If you are interested in their source, I'll be glad to give them to you privately, since no one of them comes from my own institution. Recently, we have had the very interesting, even though somewhat fatuous, statement: "We need to get more teachers who are interested in evaluation rather than measurement." This semantic massaging continues. A distinction is made between two kinds of operations, one of which bothers the author. This is called "measurement". I am not sure what is involved in it. Evaluation, however, a more favorable term, is ambiguous enough to permit anything intelligent to be said under it.

Another and more recent statement interests me even more because I think it is particularly naive. A very prominent person made the statement that he does not want to use tests when he is working with pupils because he "wants nothing to intervene between himself and the pupil". This is a rather interesting statement and also is an argument against a lot of other things, if you think about it very carefully. This person thinks "tests are biasing". Apparently there exists an osmotic process whereby an instructor immediately perceives all the manifestations of the behavior with which he is confronted, and tests would get in the way. Statements like this represent what I call sentimentalist factors among educators. There may be some sentimentalists in this room. In that case, I won't apologize; I'll merely accord you the courtesy of not identifying you by name.

At the other extreme, there is the kind of person who just loves to take correlation matrices and rotate axes through them. He doesn't care what comes out as long as the decimal point is in the correct place. These people, I think, also are not being very helpful.

Well, no one of these two groups is represented up front today. Probably some are in the audience, and you may be quite irritated with some of the comments to be made, because all five people are going to speak rather frankly - and, I think, very intelligently. I read the papers, and I agree with every single one of them. There is one slight conflict of which Dr. Tyler and Mr. Rourke are not yet aware. And I think Mr. Ebel will be shocked to hear one of the things that Dr. Tyler will say. He doesn't know about it, but he has already written his response. He's going to have to do some rapid modification in the course of the morning. These people are going to strongly and forcefully speak on the assumption that you are willing to listen and perhaps be persuaded.

At the end of the afternoon, I have some other comments which I hope will be relevant. I have already taken some of the time from each of the speakers. I will introduce them as we go along.

We are going to start off this morning with Dr. Tyler, whom you all know. I'd be very surprised if people in education didn't know about him. When someone asks, "How are you?", you immediately respond, "Fine." (Sometimes you respond "Fine" before someone asks, "How are you?") This sort of thing happens almost every time educators sit down to plan a conference. One asks, "Who will be the main speaker?" The immediate response is "Ralph Tyler". This makes his schedule a rather tight one. He was in Philadelphia last night. He was in Detroit this morning. This is a consequence, I think, of the question, "Whom will we have as the main speaker?"

As the program indicates, Dr. Tyler is Director of the Center for Advanced Study in the Behavioral Sciences; but historically, he has been more closely identified with the University of Chicago. He might some day return if his Board ceases to be magnanimous. He took his Ph.D. in 1927, after serving as a high school teacher in the science area in Pierre, South Dakota and in Nebraska. He taught at the University of Nebraska, Ohio State, and North Carolina. As you know, while he was at Ohio State, he conducted a series of studies, which have always interested me, on the relationship between information and the ability to use it. At Chicago, before he came to the Center at Stanford, he held a series of positions. He was Dean of the Social Sciences Division, University Examiner, and Chairman of the Department of Education. He is perhaps more closely identified with the eight-year or the thirty-school study, of which he was director. He also has acted as Director of the Examination Staff of the United States Armed Forces Institute and directed a cooperative study in general education, a college level study, some years ago.

He has been consistently one of the most influential people in American education, and I think you will see why. He is going to talk about "Background for Recent Curriculum Developments". Dr. Tyler will speak frankly about some of the issues to which Mr. Rourke will speak later, but he will talk in such a way that you will think he is talking about somebody other than you. Mr. Rourke will make you uncomfortably aware of the fact that is talking about you. This is why Dr. Tyler is Director of the Advanced Study Center and why Mr. Rourke is not.

BACKGROUND FOR RECENT CURRICULUM DEVELOPMENTS

RALPH W. TYLER

The papers in the East yesterday made a good deal of the cancer of Arthur Godfrey, but I'm happy to see we've discovered a substitute.

This is a regional conference, but I notice in the current issue of the Saturday Review...

that Wallace Stegner said there is one area in this country that is not a region. That is the western area of the country. It is the one region which has a world outlook, not even limited to the West Coast or to the United States. This is not true of the rest of the country.

I had the privilege not long ago of being on a committee with Paul Cabot, the famous leader of Boston society. Several proposals were being made, and he objected to all of them. Finally, somebody said, "The trouble with you, Mr. Cabot, is that you are a conservative New Englander." He answered, "Yes, you know you Westerners always think that we are conservative New Englanders. I just visualize what you think a conservative New Englander is: a tall, gaunt, dour-faced man wearing a black, shiny alpaca coat, sitting on a jagged rock, sipping vinegar, and contemplating rape." This regional conference will not be restricted to any conservative point of view. It will be, I trust, representative of all that we are thinking of in this country.

Any effort to review the development during the past 50 years of the school curriculum of the United States encounters a confusing complexity. This is not due alone, or even primarily, to the fact that we have no centralized control of education in this country, although it is true that the variations among the 48 states are easily marked. These local variations are less pronounced than are the differences of another sort.

One may analyze the development of curriculum theory, that is, the statements of rationale for the curriculum and the related discussions which seek to explain it and to make it more coherent and systematic. One may examine the work of the persons and groups who have designed courses of study and prepared curriculum guides. One may assemble reports of the curriculum in operation in certain schools to obtain a picture of what teachers are actually teaching at a given time in the few schools on which this kind of report is available. These three reviews will give quite different content, yet each is a significant aspect of the American school curriculum.

Another factor in the complexity of this topic arises from the unusually comprehensive definition of the term "curriculum" which is currently employed in American educational circles. The term is not limited in this country, as it commonly is abroad, to refer to the outline of the content to be taught but is used to include all of the learning of students which is planned by and directed by the school to attain its educational goals. This inclusive definition covers the formulation of educational objectives, the planning, use, and organization of learning experiences, and the appraisal of student learning. It also includes not only the learning activities carried on in the classroom and laboratory, but also those at home or in extra-curriculum situations insofar as these are planned and directed by the school to attain its aims. The line drawn between the curriculum and other activities of the students is that which separates activities designed by the school to contribute to educational ends from those which are provided for recreation or for other purposes or are not part of the school's plan. It is true that the current definition of the curriculum is a more adequate one for thinking about, for planning and for conducting an educational program, but it does mean that a review of the curriculum must include a larger range of matters than would be required if the definition were limited to the outline of content to be taught.

To bring my task into manageable size, I have chosen to focus attention on the development of curriculum theory over the past 50 years with occasional comments on the ways in which courses of study and curriculum guides diverge from the accepted rationale and with still fewer occasional comments on the discrepancies between teaching practices and curriculum theory. To simplify this complex review still further, we shall examine each of three major aspects of the curriculum in turn, treating the formulation of educational objectives, the selection of learning experiences and the organization of learning experiences. Although the evaluation of the effectiveness of the curriculum is commonly included as an aspect of the curriculum itself, I shall not discuss it, since the two following papers deal with this subject.

The Formulation of Educational Objectives

A major step in most theories of curriculum development is the formulation of the educational objectives of the school, that is, the goals to be attained by its educational program. To be sure, this is not an appropriate step in John Dewey's educational philosophy in which the direction of learning is guided by careful consideration of the quality of the learning experiences. Insofar as the learning experiences provide for continuity and interaction, in Dewey's terms, the program is effective. His philosophy does not involve a distinction between ends and means. But the other chief leaders of American curriculum thought emphasize the importance of clear objectives as the basis for planning the learning experiences and appraising the results.

Since the turn of the century, there have been several marked changes connected with the formulation of the objectives of the school. One of the most obvious has been the changed conception of the nature of educational objectives. The dominant educational psychology in 1900 was based on the theory of formal discipline and expressed in terms of "faculty psychology". The mind had certain faculties such as memory and reason which could be trained or disciplined by proper exercise. The objectives of the school were stated in terms of the faculties to be trained, and the learning experiences were those exercises in which these faculties were engaged on content particularly rich in opportunities for memorization, reasoning, and the like. Certain subjects, by the very nature of their form and content, were superior means for cultivation of these faculties. Language, particularly Latin, for example, was a superior subject because the learning of it required the exercise of memory, while its grammatical structure provided exercise in orderly reasoning.

With the decreasing acceptance of the theory of formal discipline and the elimination of faculty psychology, the prevailing view became increasingly behavioral. Learning was then conceived as the acquisition of patterns of behavior which the student had not previously followed. Human behavior was defined quite generally to include all the reactions of an individual, his thinking, feeling, acting.

Educational objectives are now couched in behavioral terms. An objective is a statement of a kind of behavior pattern which the school seeks to have the student develop. In the first flush of behavioral concepts, roughly from 1918 to 1925, the objectives were commonly stated in highly specific terms, such as ability to add

2 plus 3, ability to use the indefinite article "an", ability to spell "believe", ability to recall the atomic weight of sulphur. This was a natural corollary to the prevailing associationist theory in the psychology of learning. Every number combination, for example, was viewed as a different stimulus to which the student was to learn an appropriate response. This extreme view led to the listing of nearly 3000 specific objectives for arithmetic, and nearly 2000 for English. A student had attained the goals of the curriculum when he had learned to make the appropriate responses to all of the specific stimuli, that is, when all of these innumerable objectives had been reached.

By 1925, this view of objectives had largely fallen of its own weight. On the side of the teacher, it required keeping in mind far too many goals to be remembered; and on the side of the student, it denied the development of generalized behavior patterns which quite obviously were developing. The formulation of other theories of learning which took into account the phenomenon of generalized behavior provided terms in which educational objectives have commonly been stated since 1930. For example, in 1936 the Department of Superintendence of the National Education Association published a yearbook on "The Social Studies Curriculum". Among the objectives suggested were: (pp. 320-340)

1. Acquisition of important information
2. Familiarity with technical vocabulary
3. Familiarity with dependable sources of information on current social issues
4. Immunity to malicious propaganda
5. Facility in interpreting social science data
6. Facility in applying significant facts and principles to social problems of daily life
7. Skill in investigating social science problems
8. Interest in reading about social problems and in discussing them
9. Sensitivity to current social problems
10. Interest in human welfare
11. The habit of working cooperatively with others
12. The habit of collecting and considering appropriate evidence before making important social decisions
13. Attitudes favorable to social improvement

These obviously present a conception of generalized behavior. However, although they avoid the piecemeal aims of highly specific objectives, they may be as limited in their value for guiding teaching as the earlier statements of objectives in terms of faculties to be developed unless each of these thirteen objectives is clearly enough defined to have meaning for the teacher so that he can easily think of concrete illustrations of the general aims. The developments since 1935 in the conception of the nature of educational objectives have largely focused on defining in concrete terms aims which are expressed at a similar level of generality as those above. These efforts have been applied to defining the kind of behavior implied by such general terms as "understanding", "applying principles to concrete problems", "ability to interpret reading material", and to indicating the range of content to which each kind of behavior is to be applied. Thus, the objective "to develop understanding of the basic concepts of physiology" has been defined from the standpoint of behavior and of content. The behavior "understanding" is defined as "the ability to recall the concepts, to state them in one's own words, to give illustrations of them, to recognize illustrations given by others, and to compare and contrast related concepts." The content termed "the basic concepts of physiology" is defined by listing some two score concepts which these curriculum makers have selected as basic to this science. This kind of definition helps greatly to clarify the aims of the curriculum so that they can actually be utilized in planning and conducting an educational program in terms of the prevailing conception of the psychology of learning.

A second marked change in the objectives of the American school curriculum has been in the sources used to derive the aims. To some extent all of the five major sources have been used in every period of American history, but at a given time certain sources are dominant in their influence, while others are given only minor attention. Between 1900 and 1918, the judgments of subject specialists and the prevailing conception of the psychology of learning were dominant in formulating objectives. At the high school level, the Committee of Ten used sub-committees of mathematicians, historians, language scholars, and the like to outline the objectives of secondary school instruction in these fields. Although the prevailing educational philosophy had already emphasized knowledge and skill for the layman as a major aim of the American high school, this was given little attention in deciding on objectives. No studies were made of the needs of society nor of the needs of students to help in identifying appropriate objectives.

As a result of the success of job analysis in building vocational curricula during World War I, the process of formulating objectives from 1918 to 1933 leaned heavily upon job analyses, activity analyses, word counts and other techniques for identifying the demands made on the individual by contemporary social life. At this time, curriculum makers also gave attention to the notions of educational psychologists as to what behaviors could be taught. However, during this period little attention was given to the prevailing social and educational philosophy regarding the characteristics of the good man and the good society. The opinions of subject specialists were given much less weight than in the previous period.

From 1933 to 1945, studies of children and youth served as a major source of suggestions for objectives. With an emphasis upon the responsibility of the school for meeting the needs of children and youth, curriculum commissions drew upon child study data and reports of adolescent studies to derive objectives. This largely coincided with the prevailing emphasis in educational philosophy, and to some extent the work of educational psychologists was used. But the use of studies of social demands was notably less than in the decade previous, while the opinions of subject specialists played a very minor role.

Since the second World War, the shift in emphasis among the five kinds of sources has been marked. Primary attention is currently given to the opinions of subject specialists, particularly in mathematics and science. Very little weight is currently given to studies of the learner, but the specialists are asked to outline what they believe to be important potential contributions of their fields which will be of value to laymen as well as persons planning to specialize in the field. In this respect, the emphasis is different from that in 1900. Today some attention is also being given to an examination of social demands, and to a lesser extent, to the current conception of the psychology of learning. Much less use is made today of studies of the learner than was true 15 years ago. In general, the shifts which have taken place in the primary sources used to derive educational objectives most closely parallel the changes which can easily be seen in the statements of objectives appearing in courses of study and in curriculum guides. Because the actual practice of teaching depends so largely on the habits and outlooks of the thousands of American school teachers, the shifts in practice are not so easily discerned.

A third marked change has been in the range of objectives which the American schools have not only accepted for themselves but have actively championed. At the turn of the century, there was a sharp difference between the claims made regarding the schools' general contribution in promoting citizenship and character and the working objectives of the curriculum which were focused on knowledge and skills and intellectual disciplines. The development of many basic attitudes, values, interests and habits was recognized as a primary function of the home and church, and for those habits, attitudes and skills relevant to work, the employer was expected to play a strong role. The school today commonly lists the whole range of educational goals required for the induction of young people into effective adulthood. It includes objectives relating to home life, personal-social relations, civic life, occupations, and the like. It includes not only knowledge and intellectual abilities but interests, attitudes, social and recreational skills. Frequently, too, there is no indication of relative weighting. Developing social skills and a cooperative attitude appear to be viewed as jobs as important for the school as developing understanding of basic concepts of science and the social studies or the acquisition of the skills involved in reading.

Since the level of learning required of people today is a high one, a major problem in education is to select wisely among all the possible goals the important tasks which the school can do well and to concentrate its energies effectively. Since the total educational job is very great, the home, the church, the employer, and the other potential educative agencies of the community need to be encouraged and strengthened to take their share, while the school concentrates on the things it can do best, and in many cases the things that only the school can do. Hence, the present shift in school objectives is toward a more discriminating selection, toward the kinds of learning which involve intellectual skills, which require sequential experiences to reach the necessary level of competence, and which involve concepts and principles that are not apparent on the surface and for this reason are not likely to be learned through the guidance of laymen. This shift is likely to reduce the great range of objectives, and to diminish the emphasis upon social adjustment and similar goals which fail to recognize the importance of individuality and individual creativity in responding to experience and solving problems. The increasing emphasis upon understanding and thinking as kinds of objectives, with lessened stress upon attitudes and habits as primary goals, may help to revive the conception of the individual who controls his feelings and actions in terms of his knowledge and thought rather than one who simply seeks to express "acceptable" attitudes and feelings and to do the "proper" thing. This is a shift in objectives which will be interesting to observe.

The Selection of Learning Experiences

Among the changes taking place in the learning experiences provided by the American schools, those in the prevailing notions of the nature of learning experiences are particularly significant. At the beginning of this century, the term was not used. Exercises, assignments, examples, problems were the words commonly employed to designate the learning tasks set for students outside of the class session, while the term "recitation" was used to refer to the oral responses expected of the student in the class. No mention was made of the student's mental reactions in the class, although it was clear that he was expected to pay attention, that is, to watch and listen to the teacher's presentations. When I began to teach more than 35 years ago, we had to file lesson plans for each week in advance. These plans outlined the content to be covered, what the teacher expected to do, and the out-of-class assignments to be made. The focus of planning was on the teacher.

John Dewey and other educational leaders gave wide publicity to the increasing psychological evidence that learning could be most readily interpreted in terms of what the learner was doing. It was his reactions that he learned - not the teacher's. The teacher's role was to stimulate, guide and reward the learner as he carried on the behavior which the school sought to teach him. This view placed attention upon the activity of the learner as the basic factor in attaining educational goals. By 1925, both writings of theorists and curriculum guides were commonly using the term "learning activities" to refer to the basic elements of the teaching-learning situation. Courses of study were listing reading activities, listening activities, study activities and laboratory activities in outlining the day-by-day program of the school.

By 1935, curriculum writers were pointing out certain limitations in the concept of learning activity. For example, two students might both be reading an historic account of the California "Gold Rush", yet each might be carrying on quite different mental reactions and making different emotional responses. One might be thinking of the excitement and challenge involved in the long wagon haul the pioneers made in crossing the country, thrilling himself as he imagined the Indian encounters. The other might be thinking of the rough, lawless life of the early mining community, wondering why people would leave the comforts of civilization to live in such trying conditions. In terms of the course of study, both were engaged in the same learning activity, but each was having a different experience and to that extent was learning something different. This kind of analysis led to the adoption of the term "learning experience" to refer to the reactions of the student in the situation. In 1936, Dewey's book on Education and Experience clarified this concept further by emphasizing the notion that "experience" involves the interaction of the individual with the situation. This interaction involves some mutual effects, the individual modifying his reactions in terms of the demands of the situation, and also modifying the situation through his reaction to it. Today almost all curriculum writers use the term "learning experience" and they seek to plan the learning situation so as to give direction to the experience the student has, that is, to his internal perception of the situation and his own interaction with it. This requires consideration of what the learner brings to the situation, what it will mean to him, and how he is likely to respond to it mentally, emotionally, and in action.

Beginning with James and Thorndike and exercising increasing influence in recent years is the conception of the learning situation as one which should provide for certain essential conditions of learning. Thorndike's earlier work emphasized two conditions - exercise and effect. Current curriculum guides mention such conditions as motivation, opportunity for practice, guidance of desired behavior, provision of satisfaction when desired behavior is elicited, and the like. Hence, some of the current courses of study are pointing out the need to consider these conditions in selecting the learning experiences for a particular class group from a larger list of suggested ones.

A second marked change in learning experiences can be found in their range. Although the Sloyd movement had influenced forward-looking American schools in the late 1800s to introduce manual training, not as vocational training but as a means of "learning through the hands", most of the learning exercises employed at the turn of the century were verbal ones. Listening and reciting, reading and writing represented the ways of learning the "academic subjects", except for the laboratory periods in high school science. Even the laboratory exercises were heavily verbal, with detailed instructions in the manual and a formal plan for writing up each "experiment". Map work in geography and field work in biology were strongly recommended by the writers of the period from 1905 - 1915. Most courses of study advised having children make maps and locate points of geographic interest on them. At this time, too, high school botany courses typically required the student to collect and identify 50 or more plants.

By 1910, high school agriculture was widely offered in rural areas. These were the first courses to introduce the project, or "student-initiated" enterprise, which, it was hoped, would help him to understand and to apply the knowledge he was gaining in the course. The use of projects spread to other fields and to the elementary school, thus providing a much wider range of learning experiences than schools had commonly used. The writers who urged the introduction of projects conceived of them as involving a range of experiences as broad as life itself, but in the actual use of projects in the schools, activities involving the construction of objects have been predominant. Many teachers think of a project as making, growing, or producing some physical object. The extended inquiry which Dewey thought had largest potentialities as an educational project is rarely found. The intellectual learning experiences are frequently quite minor to the physical manipulations required to complete a "construction project".

During the depression, with its great reduction in opportunities for remunerative work for youth, many secondary school leaders recommended the addition of work experience to the high school program. Although only a small minority of high schools introduced work experience as part of the curriculum, some developed well-planned programs which involved using a wide variety of work activities as means for attaining educational objectives related to science, social studies, mathematics and English, as well as vocational fields.

The greatest impetus to extending the range of learning experiences has been the technological development in communication. Lantern slides were in use at the turn of the century but were not found in many schools. At best they served only to extend the number of pictures which could be employed, to add concreteness, or to give variety to the teacher's presentation. The perfection of the motion picture, however, made it possible to analyze movements, to show time and space relationships much more graphically, and to increase the sense of reality in dealing with many subjects which require vicarious treatment. The addition of the sound track heightened the sense of reality and added another dimension of analysis. The sound-slide film gave some of the features of the sound motion picture in a more economical form, but it lacked the distinctive assets of motion. The television set made possible instantaneous viewing of events in a fashion much like the motion picture but with a further sense of the reality of the event, due to the viewer realizing that it is taking place at the same time he is seeing it. These technological developments have gone far in removing the physical limitations to providing as wide a range of learning experiences in the school as those of life outside. But much of the comprehensive, effective development of these potentialities lies ahead. They still represent a small per cent of the learning experiences provided by American schools.

The selection of learning experiences so as to provide for individual differences among students is another respect in which changes have taken place in the last 50 years. Attention to individual differences has been accentuated by two factors: the psychological studies which have identified the extent of differences among schools, among classes and among students in the same class; and the increased visibility of individual differences brought about by the enrollment in the school of children from heterogeneous ethnic groups and social classes. There are few teachers now who fail to recognize a variety of differences among the students in their classes - differences which affect interests, meanings, efforts and outcomes in school work.

Typical devices to provide for differences among students have involved adaptations in the time given for completing learning exercises, or variations in the exercises themselves, or both. The first type of adaptation requires a plan for students to work at varying rates. Among the early developments were the San Francisco, Dalton and Winnetka plans, all of which involved organizing the school day into two parts, one for group activity and the other for individual work. These plans also required the development of a series of assignments with full directions on paper so that the students could work as individuals on different assignments at the same time. As a student took an assignment, it became his "contract", which he undertook to finish before he went on with another assignment in the same field. He might, therefore, complete his assignment much earlier or much later than the average.

Adaptations of the learning experiences themselves were first found in courses of study which marked some of the exercises as those to be required of all students and others as optional for the better students. By 1915, this was common among American schools. By 1925, a number of cities had introduced "ability grouping" in which the course of study was differentiated in such fields as reading and arithmetic into three levels - the superior, the average, and the slow sections. These three courses of study differed in the time provided for learning exercises and to a lesser extent in the nature of the exercises. In reading, the amount of material dealing with personal and social activities of children was greater in the slow sections, while the adult material was greater in the superior sections. In arithmetic, more concrete objects were counted and compared in the slow sections than in the others.

The use of individual projects was also a means of adapting to the individual student's interest and ability. This was recommended in courses of study as early as 1915. Learning exercises carried out by small groups (two to ten students) were first employed in the late 1800s to compensate for inadequate laboratory equipment. The apparatus was insufficient to provide opportunity for every student working individually to carry out the assignment. By 1930, small group projects were being used by many schools as a manageable means of providing for individual differences. The projects themselves could differ in the rigor of their intellectual demands, and the division of labor among the students in the small group could adapt further to the abilities and interests of the individual. Unfortunately, all too often the slowest learner was given some handwork which involved little if any new learning. By 1950, with the publication of research on the psychology of small groups, educational writers were recommending the use of small group projects as a means of heightening motivation and increasing the amount of meaningful learning activity. Since 1948, the attention of educational leaders has focused increasingly on the education of the gifted student. This has led to emphasizing learning experiences which require greater understanding, skill, or effort than those usually provided in the course of study. It has also stimulated some schools to develop learning experiences that can be carried on as independent work.

The most typical development in the past 20 years found in courses of study to provide for individual differences has been the listing of a large number of suggested learning experiences from which a given teacher may select ones particularly appropriate for his class as a whole or for groups or individuals within the class. The uniform lesson plan so common when I started to teach is almost unknown now. Most curriculum guides include a discussion of how to select from among the large number of learning experiences suggested in the course of study those which are likely to be most effective for students with varying backgrounds and abilities.

The Organization of Learning Experiences

Important educational objectives involve patterns of behavior of such complexity that they can be developed only gradually over considerable periods of time. For example, the ability to read critically and to make comprehensive interpretations of what one reads is not acquired in a few brief lessons. To understand the basic principles of science and to use these principles in explaining the biological and physical phenomena round about us requires a variety of related experiences extending over many hours. If the development of such complex behavior patterns as these is left to isolated or unrelated periods of learning, adequate achievement is impossible. Hence, a major phase in building a curriculum is to work out an organization of the many, many learning experiences required so that the student develops these complex behavior patterns gradually, day by day, and relates them to others so as to have an increasingly unified understanding and a well integrated command of essential skills.

The purpose of organizing learning experiences is to maximize the cumulative effect of the large number of learning experiences required to develop complex behavior patterns. Three criteria are commonly considered as standards to be met by a well organized curriculum, namely, continuity, sequence, and integration. Continuity refers to the reiteration of the desired behavior through the many learning experiences used. Sequence refers to the gradation of the learning so that each subsequent experience not only builds on previous ones but goes beyond in order to require a higher level of skill or a broader or deeper degree of understanding. Integration refers to the relation of what the student is learning in one field to what he is learning at about the same time in other fields. A broader and deeper understanding is facilitated by comprehending the relation among the various concepts, facts and principles being studied, and a more adequate command of basic skills is achieved as the relation of these skills to one another is seen.

One surprising fact about curriculum development in the last 50 years has been the limited attention given to the theory of curriculum organization. Other than the common-sense notions of these criteria and of such rule-of-thumb principles as "learning experiences should proceed from that which is known to that which is unknown, from the simple to the complex, from the easy to the difficult", no new formulations have been made since the time of Herbart and James. This is an area crying for substantial theory to be tested in practice and to provide a guide for practice.

At the more specific level, developments in reading and in foreign languages have been most marked. In reading, continuity and sequence are commonly achieved through carefully controlled vocabulary development, adding new words gradually and systematically, and through the control of sentence structure in the reading materials, beginning with simple declarative sentences and moving gradually to compound and complex ones. Integration is sought both by relating the reading material to the common activities of the children and by introducing work-type reading in the other subjects on a gradual basis. A similar scheme of organization is commonly followed in the foreign languages.

In arithmetic, the development of skills is usually facilitated through an organization which begins with learning experiences involving addition and subtraction, then multiplication and division, then common fractions and decimal fractions. No explicit scheme of organization for concept development in arithmetic can be found in the current courses of study. The content of arithmetic problems has changed greatly since 1900. Beginning about 1920, studies were made of the kinds of problems commonly encountered by children and adults. Typically, arithmetic courses now order the problem content in terms of frequency of occurrence of the problems outside of school and in terms of the age level at which this kind of problem is commonly encountered by children.

The typical high school curriculum in mathematics has changed little in the past 50 years so far as organization is concerned. Tenth grade geometry builds little, if at all, upon algebra. Advanced algebra and solid geometry in the eleventh grade have little sequential relationship to tenth grade geometry, and trigonometry in the twelfth grade does not provide a clear sequence for the eleventh grade work. The so-called "modern mathematics program" which is now getting under way with the sponsorship of the mathematical organizations should provide a much better organized curriculum for high school mathematics.

In organizing the so-called content fields, like the sciences and the social studies, major attention has been given to the ordering of content rather than behavior. At the beginning of this century, science was not commonly taught in the elementary school, while in the high school, botany was most frequently offered in the tenth grade, physics in the eleventh, and chemistry in the twelfth. By 1920, general science was offered as the introductory science course in more than one-fourth of the high schools, and now it is taught in almost all schools in the eighth or ninth grade, with biology in the tenth and physics and chemistry, where offered, being placed in the eleventh or twelfth grades. The content of general science is usually selected to relate to the scientific phenomena most commonly observed by children. The content of biology is usually chosen to explain the human body, the maintenance of health and the conservation of natural resources. The organizing notion here is to begin with phenomena which are common in the student's environment and in which he is likely to be interested, The advanced science courses, physics and chemistry, deal with the more abstract principles, which are thought to be less common and more difficult. The organization of these two courses has not greatly changed in the past 50 years. These illustrations in the field of science indicate the attention given to organizing the content dealt with in the learning experiences, but no similar effort has been made to organize the behavior, that is, the skills and abilities to be developed.

This is also true for the social studies. The changes taking place in their organization have been changes in the ordering of content. The most common sequence of content in the social studies is to begin with the community, then the state, then the nation, and finally the world. There is little evidence to indicate that this is sequential in terms of difficulty in learning.

Thus far, we have been reviewing the continuity and sequence of learning experiences in the content fields. The problem of integration, that is, how to relate learning experiences so as to aid the student in seeing the relations between what he is learning in one field with what he is learning in another, has been attacked most commonly through changes in the structure of the curriculum. In 1900, the elementary school curriculum was composed of 10 or more specific subjects like reading, writing, spelling, arithmetic, geography, history, nature study, hygiene, music, drawing. Now, the typical course of study includes reading and the language arts, arithmetic, science, fine arts, health. This reduction in the number of subjects has been accomplished by building a more closely related series of learning experiences in language, in which reading, writing and spelling are involved; in social studies, where geography and history are interrelated; and in the fine arts, where music, drawing, and painting are brought together.

In the high school, the broad fields of English, mathematics, science, social studies, foreign language and fine arts have frequently replaced more specific subjects, and in some cases the core curriculum has been developed, which provides a large structure for learning experiences that occupy from one-third to one-half of the high school student's day. Since these larger structures are usually planned as courses rather than several separate sub-courses, there is opportunity for better integration. Typically, however, the only principle of integration which has been explored is to bring together the content and skills needed to deal with each of the student "problems" which provide basic units of the course. This principle does not always provide for the necessary continuity and sequence nor for all of the more helpful relationships among the fields which are involved. In many cases, a particular problem involves knowledge or skills from certain fields in only a minor degree and does not suggest the more significant ways in which these fields are related.

It is clear, after reading the works of curriculum theorists and examining courses of study, that the past 50 years have not been a time of great development in the organization of learning experiences. In this respect, curriculum changes have been relatively few. The careful, systematic work done in the field of reading is a shining exception. The arousal of interest and stimulation of thought among secondary school teachers who have worked on the construction of core curricula suggest the great intellectual resources available under effective leadership to attack fundamentally and systematically the problem of developing a better organized curriculum.

Summary

This review of changes in the curriculum of the American schools during the past 50 years has touched several high spots, but it has not presented possible explanations for the kinds of changes noted. It is probable that many of these developments can be understood in terms of the tasks which the American schools were facing at these different periods and the ideas prevailing in the field of psychology which school leaders found when they sought assistance from scholars in attacking critical school problems.

In the period prior to World War I, the elementary school was steadily growing to include a larger per cent of the children of age 6 to 14. The critical task was to teach the three R's to children of immigrant parents and those from the working classes. This required a re-examination of the psychology of reading and arithmetic, for the usual background of interest in and experience with language and children's stories could not be taken for granted, nor could early experiences with number concepts in the home be assumed for all children. It is not surprising that in this period long lists of specific objectives for these subjects were worked out and that special attention was given to children's interests and abilities in devising learning experiences.

World War I ushered in a 15-year period when the economy developed rapidly and workers were in demand. No wonder that job analyses and other forms of analyses of social life were used to identify more definitely the demands which the individual would be expected to meet, and to use this source in setting objectives. From 1930 until World War II, the great depression increased rather than decreased the number of youth in school because of the limited opportunities for employment. But the same limitations in jobs made the analysis of social demands a less relevant source for educational objectives than a study of youth themselves to find needs and potentialities that might justify educational effort when no great social demand was apparent. This period also was a difficult time for many secondary schools because youth saw no future and had no interest in deferred educational values. In their eyes, school work had to be justified immediately in terms of its interest and meaning to them. Hence, the devising of learning experiences of immediate interest and relevance to students and their organization around student problems helped to meet this pressing problem.

Since World War II, the insatiable demand for technically trained people has focused attention on the opinions of subject experts as a source of objectives and has given greater emphasis to knowledge and skills. The current demand for highly competent professionals and technicians has increased the interest of the schools in the education of gifted children and in devising a better organized curriculum to reach high levels of achievement. The shortage of teachers has furthered the demand for technological devices that increase the range of learning experiences, such as television and the sound motion picture.

Throughout the last 50 years, the schools have been pressed by continuing conditions which create critical problems that cannot be solved without further curriculum developments. The first of these is the rapid change in technological development and social life, which requires a continually increasing level of education on the part of our people. The second is the increasing proportion of children and youth who are sent to the schools for education. The third is the dislocation in other educational institutions, the home, the church, and the neighborhood, which rapid social change has engendered. The educational needs of today and the immediate future are greater than ever before. American education has done an amazing job in getting almost all children and youth in school and providing schools for this immense number. The schools have been astoundingly successful in building confidence on the part of the public in the capabilities of education in building our civilization. The time has come, however, to recognize realistically the magnitude of the job, to identify the objectives which the schools can best attain, to encourage the home, the church and other institutions to undertake the tasks appropriate to them, to devise learning experiences clearly relevant to the schools' proper objectives, and to work out an organization of the curriculum which aids the students in attaining a high level of educational competence. These steps still lie ahead of us.

CHAIRMAN COLADARCI: Does anyone have a question or a response for Dr. Tyler? As I told you earlier, he voices his criticism in such a way that it sounds like he is talking about somebody else, so it's safe to speak. If there are no questions at this time, you may bring up questions later during this session.

Our next speaker, Mr. Rourke, is a threat for me. I spent some time with him last night at dinner. Usually, I have a lot of fun with a person who has such a delightful sense of humor because I enjoy the interchange. But last night I seldom had a chance to say anything, and he always had the last word. I warned him that I would get even when I introduced him. He reminded me that he would be speaking right after I did, which has silenced me again.

Let me note for you that Mr. Rourke is from Kent School, which is a small institution in Connecticut. I don't believe the recent canard that some organization on the East Coast has sponsored a contest, the first prize for which is a one-year scholarship to Kent School. This sounds tremendous, except when one notes that the second prize is a two-year scholarship to Kent School.

Mr. Rourke is a Canadian. He graduated from Queen's University in Kingston, Ontario, in 1927 with honors and a gold medal in mathematics, the field which he represents. He had graduate training at Harvard in '29 and '31, where he took a Master's in mathematics. He was at Pickering College in Newmark, Ontario, from 1928 through 1947, where he ended up as Head Master and, between-times, a math teacher and Assistant Head Master. He has been at Kent School since 1953 and is head of the Department of Mathematics and Science. Mr. Rourke has taught from time to time at other places: Queen's University, University of Alberta, and Teachers College of Columbia, where he is now completing what is euphemistically called a sabbatical, and during which time he has worked very hard with the Commission on Mathematics. He is going to speak about this work.

The man has had a distinguished career in his field, and his career has been a very influential one. He is one of the persons involved in Dr. Tyler's reference to current developments in the structuring of mathematics education. He has been an executive of the Canadian Mathematical Congress, a member of the Advisory Committee, School Mathematics Study Group, Director of the National Council of Teachers of Mathematics, and Executive Director of the Commission on Mathematics for the College Entrance Examination Board.

He is co-author of several texts. I won't note them all to you, but I want to read a few titles, because there is a very interesting and non-accidental structuring of the order in which the texts are listed. The first one is An Advanced Course in Algebra;

the second, Plane Trigonometry and Statics; and third one is Mathematics for Canadians, which is in six volumes. The last one, which follows immediately on the six volumes, is called Why Study Mathematics? - a question which I presume he will answer.

Mr. Rourke would like to present to you the kinds of thinking that have gone on in the Commission on Mathematics, a report of which has recently been issued. I shudder to think what else he might say. I have only the advantage of knowing that I will return. Mr. Rourke!

RECENT CURRICULUM DEVELOPMENTS IN MATHEMATICS

ROBERT E. K. ROURKE

I was informed that he would get me off with one foot on a banana peeling, and you can see what has happened. I'm glad he spared me the indignity of referring to Kent School as the school with the micronite filter. As a matter of fact, I didn't think the introduction was too bad. If I thought he could have delivered lines like that, I would have written more of it for him. I just want to say that I was told that Dr. Coladarci was the poor man's Groucho Marx and that I should stand back and get ready. But I want to say, Sir, that I found you very kind and generous, and not nearly as offensive as your friends told me to expect.

This morning I should like to give you some notion of what has been going on in the field of high school mathematics. In particular, I want to discuss the work of the Commission on Mathematics of the College Entrance Examination Board.

Anyone who can read a newspaper is aware of the fact that during the last few years there has been a ferment in the field of mathematics, and that this ferment has extended all the way from the first grade to the graduate school. There is sweeping up to be done on all the floors of the mathematical skyscraper. Not long ago a speaker addressing a meeting of teachers and mathematics educators said: "It's a great joy to speak to a group of people who are working in a field in which nothing has happened in 500 years." He couldn't be further from the truth if he were trying for an intercollegiate prize. I think that in the whole field of knowledge, with the possible exception of some branches of physics, there has been no area that has undergone such lively and even spectacular development as mathematics has undergone in the last 50 years. A number of projects have been concerned with the implications of this development for high schools, but the one with which I am most familiar is the Commission on Mathematics. Consequently, most of my remarks will have to do with the work of this group.

The Commission on Mathematics was called together by the College Entrance Examination Board in 1955. Kindly note the date. There were no sputniks in the air at that time, and we are not a product of the post-sputnik panic. Too often in this country we panic under strain. During my recent visit to Russia, it became clear to me that Russians expect the American people to panic. I wonder how many of Mr. Khrushchev's decisions are postulated on this assumption.

There is a relevant story about a Chinese engineer who was talking to an American engineer. The Chinese engineer said, "You know, we admire you American engineers. You are the greatest engineers in the world. What magnificent bridges you build! What magnificent highways! But there's one thing that baffles us. We don't know why you panic so easily." "Well," the American replied, "I don't see the justification for that remark." To which the Chinese added, "Let's just think of a typical situation in my country. Now, in China, for example, when we want to put a tunnel through a mountain, it's an exceedingly simple operation. We put 5000 people at one side of the mountain and we start them digging; then we put 5000 people at the other side of the mountain and start them digging. If they meet in the middle, then we've got a tunnel." "Ah," said the American, "but suppose they don't meet in the middle." "Then," replied the Chinese, "we've got two tunnels."

Note, then, that in August 1955, Mr. Frank Bowles, President of the College Board, called the Commission together. He wanted us to take a fresh look at the program in high school mathematics in view of the new and increasing demands the Twentieth Century was making upon this subject. The Commission, composed of school and college teachers and mathematicians, met in Ann Arbor, where we soon came to the conclusion that the time for a change was long overdue. And I should like now to tell you why we came to this conclusion, what we decided to do about it, and how we went at the job.

Why should there be a change in the program of school mathematics at this particular time? Is there a real need for a change, or is this just another periodic eruption like those of the Thirties, when the teachers of mathematics were regularly going from crossroad to crisis? In those days, unfortunately, we teachers were rather ineffective salesmen for our subject. Or perhaps the American people were not ready to face the facts concerning the role of mathematics in our society. Conditions are very different today. The urgency is there for all to see.

First, the development of new mathematics has been fantastic. A mathematician said not long ago that since the year 1900, the amount of new mathematics that has been discovered exceeds by the factor 10 the mathematics known previous to that time. It takes some 1200 pages a year just to list the results of new mathematical research.

Some will say, "Yes, but this development is at the frontier. What in the world has it got to do with the high school program, with the elementary school program, or with freshman-sophomore programs at college?" The answer is that a great deal of it has nothing to do with these programs, but the answer is also that parts of it have very serious implications for those who teach in school and college.

I am a teacher, and I have been a teacher all my life. And I speak to you as a teacher when I say that this great wealth of new mathematics and new applications of mathematics can help us to offer our talented students programs that are exciting, significant, and challenging. This fact was recently underlined by some documents sent to me by the Organization for European Economic Cooperation. Now, this is not a mathematical organization. It is not even an educational organization. Its job is to assist in the economic recovery of the western world. And the documents report that O.E.E.C. has encountered a roadblock in carrying out its job: it cannot do effective work in terms of economic recovery in the western world without significant changes in the teaching of high school mathematics.

Some people have concluded that all the significant changes and all the most spectacular uses are found only in the newer mathematics. This is simply not true. Some of the most startling achievements have been made with the aid of mathematics long since known, a branch of mathematics called analysis. The magnificent work done in connection with the International Geophysical Year in the ionosphere, in dealing with deep ocean currents, and in studying the earth's magnetic field - all these results stem from applications of analysis. The old stuff is still going great guns.

But mathematics has a lot of new customers. When I graduated from college, I could do one of two things. I could be a teacher of mathematics, or I could be an actuary. There were no other jobs for me. Today, when I try to get people for my department at Kent School, I find myself in competition with Westinghouse and General Electric. New uses of mathematics have opened up a great many new jobs. Although the physicists and the natural scientists are still our best customers, we have important new customers who are demanding attention. For example, the social sciences are using mathematics in increasing amounts and in great diversity. A professor of social science told me not long ago that, in many social science courses, you can't get very far without the ability to handle a good course in probabilistic thinking. Probability and statistics, the mathematics of uncertainty, are good, solid mathematics.

And we are not travelling on a one-way street: the social sciences contribute problems that lead to the development of new mathematics. For example, the theory of games, one of the most promising of the new branches of mathematics, was suggested by problems in economics related to competition and cooperation. I could go on to cite examples from business and industry. You are familiar with words such as "operations research", "automation", and "quality control". These indicate something of the scope of the new applications of mathematics.

We must face frankly the fact that we have come into a new technological era. Let me quote from the Rockefeller report: "First, the crisis in our science education is not an invention of the newspapers, or scientists, or the Pentagon. It is a real crisis. Second, the U.S.S.R. is not the 'cause' of the crisis. The cause of the crisis is our breath-taking movement into a new technological era... The immediate implications for education may be briefly stated. We need an ample supply of high caliber scientists, mathematicians, and engineers... We need quality, and we need it in considerable quantity."

I do not wish to raise the bogey of Russia, but I must state at this time a personal conviction. I believe we are engaged in a mortal combat. If you had followed me around the schools of Moscow, Leningrand, and Kiev last fall, I think you would have shared this conviction. Never have I seen young people and teachers with such well-focussed motivation, with such determined drive. The secret ingredient of the Russian program is work. I saw a nation with its sleeves rolled up. Some of their teaching methods are almost pre-Cambrian. But the results are surprising. I was impressed particularly with their very gifted students. At times, I was almost forced to the conclusion that the really gifted student is impervious to all pedagogical abuse. He just needs a library. After going from class to class and seeing the intensity with which these young people and their teachers are working, I simply cannot come back and speak comfortably to Jerusalem.

If we are going to meet the challenge of this new age, in some way or another we've got to provide more challenging programs for our talented - not only the talented in mathematics and science, but for all our talented. I don't want to give the impression that I would like a world filled with mathematicians. Heaven forbid! I can't imagine anything more disagreeable. Fortunately, the Creator has made this impossible. But for the college-capable we must get programs that are challenging and exciting. Believe me, we have exciting mathematics today. In my high school, I haven't for some years been able to get anyone in the Student Guild to give a paper on traditional mathematics. I find myself saying, "This traditional mathematics has some fascinating ideas. Don't overlook them." But there is no question that the ideas that excite gifted young people the most are those of the new mathematics.

These then were some of the reasons why we on the Commission felt that something must be done -- and that, with all reasonable speed, for the developments of mathematics, its growth and its uses, have far outrun the curriculum. But what to do? Well, we decided to select from the large problem a part that we felt qualified to tackle, hoping to find a good first approximation to a solution. So we aimed to improve the mathematics program of grades 9 through 12 for the top 15 or 20 per cent, which we call the college-capable. Now, this does not imply that we think the non-college-capable are not important, or that grades 1 through 8 are not important. It does not imply that we feel that grades 13 through 16 are not important. It simply means that we had a vast problem in front of us, that we couldn't do it all, and that we picked out a piece of the job that seemed within our powers, hoping that other organizations would come along and fill in the gaps. I am happy to report that this is exactly what is taking place. Finally, our decision did not involve an evaluation of human worth, but rather an evaluation of mathematical potential. We can no longer neglect our responsibilities for our college-capable young people.

Beginnings are difficult. In designing a new program, you can begin by throwing out the old one. Some prefer to handle the problem in this way. (In my opinion, this is the method being used at the University of Illinois. And I should like to pay tribute to the fine work they are doing. I believe that theirs is a longer range program than ours.) On the other hand, the thinking of the Commission went something like this: Since much of the traditional mathematics is still important and significant, let us strive to develop an improved program in which the new grows out of the old in a way that makes reasonable demands on teachers and administrators. In short, let us try for a program that is oriented to the future, involving changes that can begin at once gradually and proceed forward rapidly. I believe that the Commission's recommendations exemplify such a program - a step forward that is both real and realistic.

How did we work out the details of this program? With a team composed of mathematicians and teachers of mathematics. There are those in mathematics who excel in exposition and communication, and there are those who discover new mathematics. We do not usually find all of these gifts in one individual. But, in designing a new program, all of them must be available. Thus, when it comes to deciding whether a certain mathematical idea is relevant, important, obsolete, obsolescent, or teachable at a given level, the team provides the best answer. If we are going to do effective work in improving our mathematics programs, I believe (and this is one of the fundamental tenets of the School Mathematics Study Group) that we must have teams of mathematicians and teachers - college people and school people-working together. A later development, and one that we all welcome, took place in Chicago recently when psychologists, mathematicians, and teachers consulted to lay plans for an improved program in elementary school mathematics.

One of my greatest professional experiences has been that of working with mathematicians. Teachers and mathematicians in the writing teams of the Commission found that they needed each other. Each had something to learn and something to contribute. At the first meeting of our writing group, we were all somewhat diffident. We thought there were going to be misunderstandings and violent differences of opinion. But such misgivings proved to have no foundation in fact. Differences of opinion were followed by highly constructive discussions leading usually to modifications of viewpoint and to meetings of minds.

I was reminded of the man who invented a wonderful button. He claimed, "When you press this button of mine, no light goes on, no fan starts whirring, no refrigerator goes into action. No, Sir, when you press this button of mine, it simply presses back on you and makes you feel wanted." In our work with the Commission, we pressed back on each other, and both parts of the team felt wanted.

I have talked about the "why" and the "how". Now what are some of the recommendations that we make in our Report? What are some of the things that we urge for the modification and improvement of high school mathematics for the college-capable? Let me make it clear at the outset that the Commission never has believed that there is a unique program in mathematics suitable for all schools from Maine to California. This would be folly indeed. But we do believe that there are certain ideas that are worthy of general consideration.

The first recommendation to which I should like to call attention urges a thoroughly revised estimate of what should constitute a minimum study of mathematics for college-capable students. A year of algebra and a year of geometry are shockingly inadequate. We believe that it is the job of the home, the school, and the guidance counselor to let talented young people know that many doors are closed to them these days if they haven't a solid foundation in high school mathematics. And these are not only doors leading to the natural sciences. All too frequently, a boy or girl proceeding to the study of social sciences finds little resistance to the dropping of mathematics early in high school. This may have most unfortunate consequences. Talented young people, we believe, should get a minimum of three years, and preferably four years, of college preparatory mathematics, even if they do not plan to study mathematics or the physical sciences or engineering in college. They may well find their mathematical needs bounded only by the limitations of their talent.

As for content, the Commission on Mathematics is recommending a program that is about 80 per cent traditional. We have been criticized for having too conservative a program and for having too radical a program. Any teacher who studies the program carefully will realize that most of the material is the same that has been taught. What we do recommend is a marked change in the spirit and in the methodology of the teaching. We want to breathe into the program new points of view, in which certain ideas and concepts that mathematicians have found to be powerful and important are used to simplify, clarify, and unify much of the traditional material.

We are not for one moment suggesting that concepts replace skills. I hear some ridiculous statements to the effect the Commission has little use for mathematical skills. This is nonsense. We have never regarded concepts and skills on an "either-or" basis; the Commission on Mathematics regards concepts and skills on a "both-and" basis. We won't settle for one without the other.

What are some of the things that characterize this new spirit? One thing that we should like to bring into the teaching of mathematics should begin quite early in arithmetic. This is an appreciation of mathematical structure, or as Sawyer has called it, "patterns". The properties of the number system, we believe, can be reconstructed quite early in the experience of young people to give meaning to mathematics. Basic laws support the mathematical structure in the same way that steel girders hold up a skyscraper. The full importance of these laws has been brought into the spotlight only within the last 30 to 40 years. Yet these principles can and should be discovered quite early. Now, some people have taken this to mean that the Commission wants to teach abstract algebra in the eighth or ninth grade. Not at all. We are not foolish enough to believe that the abstract should precede the concrete, but students can learn more about both abstract and concrete than is commonly supposed. The only thing holding back many of our able students is the inadequacy of their teachers, of whom I am one. It is a sobering thought when I realize that today students in the eighth grade in my school can handle inequalities better than I could handle them as a sophomore at college. Two fallacies that we teachers must avoid are the notion that if something is new for us, it's impossible for our students; and the notion that if we learned a topic in the fourteenth grade, our students must learn it in the fourteenth grade. We must never forget that, in dealing with talented students, many may be far more gifted mathematically than we are. Sometimes about the best thing we can do for the very talented is to get out of their way.

But let us return to a consideration of patterns in mathematics. These patterns, or structures, pervade mathematics. You find them in arithmetic, and they recur in algebra, geometry, and trigonometry. For instance, there is the law that, for any number $\underline{a}$, $\underline{a}$ times 1 equals $\underline{a}$. Now, that may not seem like very much to you, but the implication that you can multiply any number by 1 and leave its value unchanged turns out to be a very basic principle. It enables us to perform all sorts of transformations and simplifications on fractions, for example.

Another principle of great importance is symbolized thus: $ab = ba$. What does this important property of numbers mean? It means that if you are multiplying two numbers like 3 and 5, the order doesn't make any difference; you can take 3 x 5 or 5 x 3. This basic property of the number system has profound implications. Most operations in life don't work that way. The order usually makes a difference, as in putting on one's shoes and socks. I heard one teacher ask a pupil,"What does 'ab = ba' mean to you?" The youngster replied, "It means the multiplication tables are cut in half." Good for him. He saw an important consequence of the law. He didn't have to learn different results for 3 x 5 and for 5 x 3. The foregoing are examples of patterns and illustrate what we mean when we talk about an appreciation of mathematical structure- the appreciation of the properties of our number systems.

I should like now to mention another important point in the Commission's program. We recommend the use of ideas that unify the study of mathematics. In particular, we believe that the notion of a "set" provides us with a good language with which to talk about much of high school mathematics. Contemporary mathematics has given us the idea of a set, which is just a collection of objects. You use the idea when you talk about a set of dishes, a set of golf clubs, or a set of stamps. This concept of a set is pervasive in mathematics. Virtually all the mathematics we know can be developed from the concept of a set and the laws of logic. I am not talking about introducing complicated set theory in high school. As a teacher, I say this: I can introduce algebra more effectively by using the idea and language of sets than by any other way I have ever devised. It is a magnificent unifying concept.

The Commission has further recommendations. We urge teachers to teach algebra so that it emerges as a deductive science, not just a bundle of tricks. There should be proofs in algebra, as well as in geometry. And we propose that in geometry we face frankly the fact that in the last 2000 years we have learned something about the subject. We must go beyond Euclid now, repairing defects and removing blemishes in so far as is possible and reasonable in high school mathematics. For one thing, we can introduce coordinate geometry and make use of our wonderful number system. Euclid didn't have a good number system, but we have, and we should use it in geometry.

I suppose the most revolutionary thing we are suggesting is that a course in probability with statistical applications might be tried in the twelfth grade. (This is just one of the possible courses recommended.) We have enough evidence at hand to say that if the teacher is qualified and if the students are able, such a course offers an exciting semester for grade 12.

Our main objective is to provide for the academically talented a program that will prepare them, both in terms of concepts and in terms of skills, to tackle calculus. Analytic geometry and calculus should be the standard freshman course in this country. I think it is a national disgrace that, at the present time only some 10 or 15 per cent of students who study mathematics as college freshmen are able to study calculus. Too many of our colleges are still offering high school mathematics and giving college credit for it. The sooner the situation is remedied, the better. Some ask the Commission on Mathematics, "Why do you not want to introduce calculus in the high school?" We have no objection to the introduction of calculus in high school if it can be offered as set forth in the Advanced Placement Program. This means a solid year of it. But we do not recommend a little dab of calculus. We feel that the basic job of the high school is to prepare students for calculus in terms of concepts and skills. Moreover, in general, few teachers are prepared to offer a sound course in calculus. Much harm may be done by rushing into mathematical responsibilities for which due preparation has not been made.

How do we propose to implement this program? Obviously, nothing is going to happen unless somehow or other a great array of teachers can be persuaded to give it a try. This presents a major problem for teacher education. All of which gives rise to the question: "Is there any interest abroad in the land?" In my opinion, there is terrific interest abroad in the land. I can recall nothing to match it in mathematics education. Conferences, institutes, and curricular experimentation are the order of the day. Teachers have written to the College Board for 300,000 pamphlets and over 20,000 copies of the text on probability and statistics. We plan to distribute 60,000 copies of the Commission's Report. Above all, programs for the inservice training of teachers are receiving financial support and evoking teacher interest on a scale without precedence in this country.

I don't want to leave you with the impression that the Commission on Mathematics of the College Board is the voice of one crying in the wilderness. The Commission has been discharged. Its members are now working with other groups, such as the School Mathematics Study Group, which has the men, the money, and the resources to tackle the problem in a much broader way than the Commission has done. The School Mathematics Study Group is now busily engaged in a program extending from the first grade to the fourteenth. Great things are happening, and I am very optimistic about the future. Never in my professional experience have so many teachers been active in study and interested in moving forward.

How can teachers prepare to meet the demands of these new programs? Pre-service training and inservice training are involved. Of the two, the pre-service job is probably the easier. Inservice training is a big job, requiring that teachers study as they teach, whether it is self-study, group-study, conference-study, or institute-study. Wonderful opportunities are being provided for teachers, particularly by the National Science Foundation. Over a period of years, there will probably be enough institutes to accommodate almost every teacher in mathematics who wishes to attend.

In addition to the publications of the Commission on Mathematics, we shall soon have a great wealth of material for teachers in the form of pamphlets, books, and texts. As of September of this year, the School Mathematics Study Group will have for experimental use a complete series of texts for grades 9 through 12.

The Maryland project has already undertaken wide experimentation with materials for grades 7 and 8. These grades, in the opinion of many, are thin spots in the mathematics program. I am astonished at the ideas that are being put into those programs. You have to watch yourself. I've found myself getting into the fallacy of saying, "I have never done it. I wasn't taught this way. I don't think it can be done." Then, I talk to teachers who are using these new Maryland materials. Almost without exception, they report that the materials are exciting to them and exciting to the students.

I should like to conclude with this thought: These are challenging times for teachers of mathematics. Truly wonderful things are happening in mathematics education. Let no one fail to make his full contribution. It is indeed a time to teach and a time to learn.

Note: The following information is added for those who may wish to obtain materials mentioned in the foregoing. For all publications of the Commission on Mathematics, write:

College Entrance Examination Board
c/o Educational Testing Service
Box 592, Princeton, New Jersey

For all publications of the School Mathematics Study Group or of the University of Maryland Mathematics Project, write:

School of Mathematics Study Group
Drawer 2502 A, Yale Station
New Haven, Connecticut

CHAIRMAN COLADARCI: Are there any questions? Sir, would you identify yourself loudly.

JOHN JOSEPH RISSER (Psychologist, Pasadena City College, Pasadena, California): Joe Risser from Pasadena City College. Many colleges experience a very high mortality in this first course in calculus. I wonder if you can make some comments as to criteria or guide posts that can make our counseling more effective.

MR. ROURKE: I believe that for effective work in calculus, students need a grounding of the type set forth in the Commission's recommendations. I do not believe that enough students are getting this kind of grounding. I think too many of them are signing up for courses in calculus when they haven't had the requisite training in algebra and so on.

A student is not ready to tackle a course in calculus until he has completed three and a half years of the Commission's program as set forth in the Report. In the Report, we say that during the period of transition, some schools may not be able to complete the full four-year program as recommended; but if they can complete a minimum of three and a half years, to the end of the course in elementary functions, we believe that this is good solid training for calculus.

Of course, there are other things involved besides preparation: goals, gifts, and guts. Unfortunately, often social problems arise in college and prevent a youngster from doing his best. Even if such a student conserves his energies magnificently, I don't care what kind of a foundation he has, he is not going to do well in calculus.

CHAIRMAN COLADARCI: Does that answer your question?

MR. RISSER: Thank you.

MILDRED ROBECK (Assistant Professor of Education, University of California at Santa Barbara, Goleta, California): I have two questions. Teachers of high school mathematics ordinarily have a major in this area. With such a background, they have had many college courses in content. Question number one: How can the methods teachers in one course repeat content and show how concomitantly? Question number two: How could content courses at the college level be taught more effectively so that content would not be necessary in the methods course?

MR. ROURKE: I should like to make a comment about your first statement. Did I understand you to say that most of the teachers have majors in mathematics? I would not concede that. Many of the teachers may have majors, but not in mathematics. Moreover, even a major in mathematics does not always guarantee solid training in content. I cannot concede your statement, if I understood you correctly.

When you ask me how these courses in content could be taught, you ask a large question. I cannot give the answer in five easy steps, but I'll tell you this: Get me a bunch of teachers together, and I'll show you how. By a "professionalized" course, I mean a course in content in which the what, the why, and the how are worked in together. When the teacher finishes that course, he knows something about mathematics, its place in the high school curriculum, and its presentation.

I want to say this in defense of the teachers: A great many of the courses that are called "majors" are not mathematics majors at all. Recently I read a description of a "mathematics major" course offered by a college in an Eastern state. This course was designed to prepare teachers to teach the senior grades in high school mathematics. After four years, teachers in the course would not know as much about mathematics as my Advanced Placement section in grade 12 at Kent School. I don't think this is the fault of the teachers. I think it's the fault of the professors who designed the course. They thought it was adequate for the needs of the Twentieth Century. They should know better.

ALEX D. ALOIA (Associate Professor of Education, Co-Director of Guidance Center, Loyola University, Los Angeles, California): What do we do about the youngster who shows great promise mathematically but has no desire to pursue mathematics or a science in which he might utilize mathematics? I think we have a great many students who show achievement in mathematics on the College Board. What can we do to stimulate this in some way?

MR. ROURKE: I wish I knew the answer to that question, Sir. The Rockefeller report talks about ability, character, and motivation. I have talked about gifts, goals and guts, the three G's. I have run into this question in every school where I have ever taught. It is one of our major problems. My answer to the question (insofar as I have an answer) is a belief, an article of faith. In terms of my own experience, I believe one way to salvage some of these students is to provide them with an exciting and challenging program. Bring them into contact with interesting ideas.

But I think there is something beyond this. The home, the school, and the church have important roles to play. I think that our students have got to find a faith to live by, something that the students in Moscow have. Communism is a religion to them. They have a doctrine of accountability. They feel accountable to the state for the full exploitation of their talents. Consequently, it's comparatively difficult to lose a talented student in the U.S.S.R. I think the Christian church has an answer in the Christian doctrine of accountability. The story of the talents, I think, tells the tale. Our gifted people must realize they have some stewardship for their gifts. I see no other effective answer.

CHAIRMAN COLADARCI: I think we had better move on. If you have a further question or wish to engage Mr. Rourke further, you will have an opportunity to do it later today. I can't resist, however, one parting shot; and then we will dismiss him for the day, officially. I was reminded of a story of a citizen who happened to visit a high speed computer lab. He was thoroughly awed by the wall full of lights. He said to the technician, "I'll bet this machine can do anything." The technician replied, "It certainly can. Ask it a question." "Anything?" asked the citizen. "Certainly," replied the technician. The man stood off and asked, "Where is my father at this moment?" The lights blinked, and out came a tape saying, "At this moment, your father is teaching mathematics at Kent School." The man stood back and said, "Ha-ha, my father, John Randall, Junior, is in his office in San Francisco." The machine blinked its lights again, and out came a tape saying, "John Randall, Junior, is at this moment in his office in San Francisco. Your father is teaching mathematics at Kent School."

Our last speaker for the morning has been put last, I think, only because he is the youngest. He will provide a study in contrast because he is a very humble person. Dr. Davis is now Professor of Physics at Reed College. He earned his degree in physics at the University of Rochester in 1948. His Master's was in physics at Syracuse, and his Bachelor's was in physics. He has been a high school teacher in physics. So far, you see all our people have been high school teachers. Dr. Davis has been science consultant to the Portland Gifted Child Program and has been very active in the National Science Foundation Institute.

This morning, he would like to describe the origins of the Physical Science Study Committee, on which he has been functioning, together with some discussion of the work of that committee and some analogous developments in other areas. When he is finished, we will have completed the first portion of our program. Right after lunch, we will turn to the question of possible implications of psychometry in this matter. Dr. Davis!

RECENT CURRICULUM DEVELOPMENTS IN SCIENCE

KENNETH E. DAVIS

The amusing and edifying interaction between two of the persons up here brings to mind a remark which is credited to one of the more glamorous inhabitants of this city when things weren't going particularly well; namely, "What can you expect of a day that begins in the morning?" This is not to cast any reflections on the kind of morning we are having.

I am sure Mr. Rourke and I owe a good deal of gratitude to the very clear exposition of the background that Dr. Tyler gave for the problems we are talking about.

It seems to be a characteristic of most human beings that only when facing a crisis, whether real or imagined, do they ask themselves penetrating and fundamental questions. The drowning man whose whole life flashes before his eyes in an instant seems to be an enduring part of our folklore. We have seen his analogue several times in recent years. A particular awareness and introspection have been common in parts of the scientific community for some time before the relatively recent events which have brought a more general public reaction. This has been alluded to this morning. It has been very carefully pointed out that the scale of these developments is not one beginning with Year 1, the year in which words like "Sputnik", "Explorer", and "space medicine" were the common language of every elementary school student.

During and immediately following World War II, some participants in the major programs of radar and A-bomb development were struck by a curious fact. If one were to list those men whose contributions to such work had been of the most fundamental and important sort, not one in the top dozen or so had had his most important training in this country. Only a few were native Americans, and their training had been received abroad. There was a good deal of conjecture as to the reason for this. It seemed that something was lacking in the scientific training provided in this country or that we were inefficient in developing talent. One feels reluctant to conclude that our population lacks its proper proportion of brains. The numbers and general conditions are such as to make one feel that in this, at least, we should have statistics on our side.

One explanation persistently offered was that unusual talent was frustrated and hamstrung by the regimentation of our educational system, up to and including college and graduate work. I would like to return to this point later. Individual observers offered solutions of wholesale cutting of red tape when exceptional talent should be discovered, but the general result seemed to be a settling back with nothing changed much after the conferences and debates.

About five years ago, the scientific community began to stir in concern once more. Surveys made of high school enrollment in mathematics and the sciences since 1900 resulted in graphs that dipped steeply in the more recent years. This is all ancient history now, but I am trying to put it in its context. Professional physicists and chemists became quite concerned, since this meant to them a drying up of the source of manpower in their chosen fields. It seemed to indicate also that fewer and fewer non-science majors were having contact with or even elementary understanding of the sciences. Since legislators and many others concerned with the leadership of our nation now need an acquaintance with science even more than ever, such a drop in enrollment in science courses would have other far-reaching effects besides reducing the number of scientists and engineers. We cannot afford to have a large gap due to lack of understanding or lack of communication grow between major segments of our society. Our citizenry generally must be an informed one if it is to make wise decisions. Certainly, we do not want to have decisions made in ignorance or have them made by a very few individuals for the many.

With such concerns in mind, groups of chemists and physicists began to meet in 1956 to discuss the seriousness of the problem and what they as professionals might do. Every profession (and every trade, for that matter) has an obligation to its continuing membership to take an active part in the proper education and training of those entering the profession. I would like to underline that statement. It is aimed at some of my colleagues who have had a stand-off attitude. In addition, the profession has the obligation to inform the general public on matters of fact to the best of its ability. For many years, the professional subject matter specialists have in large part shirked their responsibility toward their neophytes. A change seems well on its way.

In 1956, one discussion group finally crystallized into what is now called the Physical Science Study Committee. Drawing its membership from industrial as well as university, college, and secondary school physicists, it elected as chairman Professor Zacharias of MIT. Because of our national penchant for catch phrases and slogans, this has been called the "MIT Program" by some. Many people feel that this should be known as a program which came from a wider source than a single institution.

The Committee members felt that surely the high school student must not know the essence of physics as they knew it and that probably the best contribution the Committee could make as a professional group would be to try to bring some of this spirit to the high school student through short, authoritative, and interesting movies on particular topics in physics. This was the original idea, the germ from which the program started.

If one were to use such films to illustrate and supplement an existing high school course, the films should be preferably tailored to fit the existing text books. The Committee members took as a reading assignment the 12 leading high school physics texts. To a man, their conclusions were the same: The books did not tell the story of physics, or even of science generally. They found instead that the books consisted of approximately 50 per cent devoted to sections on technology, among which physical principles were stated in unmotivated, underived form. There was, to them, little of the coherence and reasoning which they knew and liked in physics; but rather, the physics that was there was fragmentary and catechismlike. They concluded that they could not in good conscience attempt to make films that would materially aid a course based on such books. They had only one course open if they wanted to offer their help: the proposed program would have to be enlarged.

I would like to straighten out one misconception which may exist. I am not a member of the Physical Science Study Committee. I am a Johnny-come-lately who was asked to help in some of their training of high school teachers.

I would like to enumerate some of the things that the P.S.S.C. then thought would be necessary for the properly rounded program. As plans took shape, they envisaged the following:

(a) A new textbook which would tell the story of science generally and physics in particular.

(b) New laboratory experiments that would involve relatively simple equipment where possible, so that the interested student might reproduce it or improve upon it at home, also simple enough so that the student would not have a "black box" getting between him and illustration of a principle or the examination of some physical phenomenon. The experiments should be well dovetailed with the other aspects of the course, and the work would flow easily from classroom to laboratory without artificial and rigid scheduling. There is another catchword which has been applied to this program, which the Committee resents and feels is too naive a summation of what they were trying and what they feel they are beginning to approach. This was the common "do-it-yourself laboratory".

(c) Seventy short movies were planned, some to be supplemental and illustrative, some to provide demonstrations involving conditions or equipment not generally available.

(d) Approximately 70 paperbacked collateral references were planned, selling for less than a dollar each, and written by authorities in the field with the help and advice of experienced teachers.

In my work with the Portland program for students of exceptional endowment, referred to earlier by Dr. Coladarci, I arrived independently at two conclusions also arrived at by the Physical Science Study Committee: (1) The existing high school physics texts are very heavily burdened with discussions of technological developments of the last 40 or 50 years; (2) There is a scarcity of collateral reference material that is at once authoritative and yet elementary enough to be intelligible to the high school student. The one exception I found was the Scientific American, and there, in the subject of physics, one finds only about one article per month.

Material in the paperbacks proposed by the P.S.S.C. is not to be assigned by the teacher, but the "Science Shelf" is to be available to any curious or interested student when he wishes to explore in his spare time more advanced information than dealt with in the text and laboratory or read about the applications and technological developments which will not be dealt with to any great extent in the textbook itself.

(e) A laboratory guide giving some constructional details or suggestions for experiments, but leaving much room for the ingenuity and inventiveness of the student.

(f) A Teacher's Guide based on the best guess as to what helps and hints the teacher would need, supplemented as soon as possible by accurate feedback from teachers trying the course for the first time.

If you are acquainted with the cost of things like this, you will be overwhelmed as I was by the magnitude of the program they are talking about. They propose to make some 70 short films. When the cost is computed for the total program, the figures are almost astronomic, and it is clear the Committee cannot pass out all the materials free of charge indefinitely. The initial funds were secured from the Fund for the Advancement of Education, the Sloane Foundation, the Ford Foundation, and the National Science Foundation.

In the summer of 1957, about 50 college and industrial physicists met with an equal number of selected high school physics teachers to work on the implementation of the plans. In the 1957-58 academic year, eight schools ran the first trial of the course, with the teachers at times living on a hand-to-mouth basis as the developing text was supplied to them.

In the summer of 1958, five summer institutes for high school teachers in the NSF general program were devoted to the materials of the P.S.S.C. program. The institutes were held at Bowdoin College, University of Connecticut, University of Minnesota, Oak Ridge Institute, and Reed College. This is where we got into this particular program. This year, some 350 schools are participating in the first large-scale trial of the course. Next summer, 15 institutes in the NSF program will devote their programs, all or in part, to the materials of the P.S.S.C. One of these institutes will be here in Los Angeles at Immaculate Heart College.

The ETS has followed the developments of the program closely and has developed, with the Committee members, a battery of tests for the course as well as a special form of the College Entrance Board Examination for those that take the course.

I feel that it will be necessary to postpone further details of this particular program itself except for a few remarks and answers to questions you may have, since I would like to comment about some of the other things that are happening in physics, chemistry, and biology. There are, of course, films that grew out of a televised program of physics in the Pittsburgh public schools. The teaching job was done by one of the most outstanding physics teachers in the country, Dr. Harvey White of Berkeley.

First of all, I have a few general observations as far as science teaching in the secondary schools is concerned. The Portland public schools are conducting an examination of their curriculum for the college-bound student. This is being done by a committee taken from the colleges of the state. They brought in some outside directing help and some examining help and are using staff members of the colleges in the state. I happen to be one of six consultants or examiners whose attention is confined to the science curriculum. Through participation in this study, I have become increasingly aware of something about which I had previously only had a few hints in other school systems. There seems to be a recognition in some school systems that the elementary school pupil is being exposed at home and in school to much of the material that has until recently been considered to belong in the ninth grade general science class. In some systems, this is leading to the immediate suggestion of putting the biology course in the ninth grade, chemistry in the tenth, and physics in the eleventh. There is a difference of opinion, if you want to call it that, as to whether the order should be chemistry first and then physics, or physics first and then chemistry. In some schools, it may be either one. There has been a suggestion that students strongly science oriented then be offered a senior seminar in science, the makeup of which is at present fairly indefinite. At least, there are many different types suggested.

The physical science course has a somewhat ambiguous status in many schools, and its future does not seem clearcut. In some schools, it is offered in the ninth or tenth grade to able students not primarily interested in the physical sciences but needing a greater spread in their science experience. In other schools, it becomes a repository for those students who have been unable to pass their state-required one year of science in any other course. Unfortunately, in some of the school systems, it becomes a class which has a mixture of the two. This, I think, is a most unfortunate situation. I will return to the idea of the physical science course a little later.

Concern for the elementary training in their fields and a better articulation between the high school and college courses is being shown in chemistry and biology, as it has been in physics.

From June 17 to June 28, 1957, the Reed College conference on the teaching of chemistry was held under the sponsorship of the American Chemical Society and the Crown Zellerbach Corporation. It was attended by 15 high school and 18 college teachers of chemistry. Most sections of the country and all sizes of schools were represented. The aim of the conference was a better interrelation of the high school and first-year college chemistry course. Principal recommendations of the conference were that a new and fundamental approach be made to the teaching of high school chemistry by adopting chemical bonds as the central theme and then an effort be made to prepare the materials needed. The conference also concerned itself with teacher training and conditions under which the teachers work. The recommendation was made that the minimum standard for certification of teachers of high school chemistry be 16 semester hours, including organic chemistry, and that the graduate training should emphasize subject matter areas in science and mathematics. They felt that high school students should be given teaching opportunities and that the use of student assistants should be encouraged through the granting of credit or financial help. A definite course plan that developed from this conference was the work of Dr. Laurence Strong of Earlham College and Dr. M. K. Wilson of Tufts College, based on the theme of chemical bonding.

This conference was followed by one at Wesleyan University in Middletown, Connecticut, June 16 to 26, 1958, with many of the participants from the Reed conference in attendance. This conference worked in three separate groups, only one of them being closely associated with the previous conference work. General conclusions of the conference favored several approaches to the problem of design of the high school chemistry course with close collaboration and feedback between the programs. They specifically felt that they did not want to commit themselves to a single approach "as the P.S.S.C. has done." The third of these conferences, sponsored by the NSF, will be held this coming summer for six weeks on the Reed College campus. I'm sorry if I keep referring to Reed. It happens in this particular instance that these conferences were backed by the American Chemical Society, and they had the first one, and now the third one, there.

Other activities in chemistry, independent of the conferences mentioned, include the following:

(a) The Manufacturing Chemists Association has produced "Science Experiments in Chemistry", published in 1958. These consist of guide sheets for 31 open-ended experiments requiring students to devise their own procedures and draw original conclusions.

(b) As a result of an advisory conference held at the National Science Foundation in December, 1958, there was set up an Interim Planning Committee which is actively developing a chemistry curriculum study. The Chairman of the Committee is Dr. A. B. Garrett of the Department of Chemistry at Ohio State. They expect to "formulate a definite proposal by the end of May".

(c) A filmed chemistry course has been prepared by J. F. Baxter and N. E. Bingham and is scheduled to be issued by the Encyclopedia Britannica Films in 1959. Some people have said this is comparable in magnitude to the number of films involved in Dr. White's program, to which I previously referred.

(d) There are various small groups working. I know of one in Redwood City where one of the high school teachers of physics and chemistry informed me that he and three other members of their school system will be working on the development of a chemistry course in a somewhat analogous form to the development of the P.S.S.C. physics course. They will be subsidized by the school system to work on it in the summer.

In biology, the earliest of the present movements seems to be the one initiated by the Committee on Educational Policies, Division of Biology and Agriculture of the National Academy of Sciences, National Research Council. In the summer of 1957, after general canvassing for original laboratory and field suggestions, a selected group of high school and college teachers of biology met for eight weeks at Michigan State University. In the preliminaries to that meeting, they issued a general call for suggestions, original experiments, pieces of information, and so forth. From among those people who submitted material, they then selected the participants. As I recall the remarks of one of the teachers, there were between five and ten times more people who submitted material than they had space for at the conference.

Their goal was to work out laboratory and field exercises according to an outline that had previously been prepared by a panel on high school courses. They produced a mimeographed manuscript which was made available to about 100 select high schools for trial and evaluation. The material is presently being revised and edited by Dr. C. A. Lawson of Michigan State and is scheduled to be published commercially this coming summer. The Committee on Educational Policies was discontinued as of June 30, 1958, since its original assignment had been completed. I say this because many of the biology and chemistry projects are much longer range than this.

The American Institute of Biologic Sciences Curriculum Study Steering Committee was established late in 1958, holding its first meeting in February, 1959, under the chairmanship of Professor Bentley Glass of Johns Hopkins University. The study is to be concerned with the teaching of biology in high school, elementary school, and undergraduate college, in that order. A full time director has been secured in Dr. Arnold B. Grobman, on leave from the University of Florida. His office and staff are located at the University of Colorado, Boulder, Colorado. At present, the Steering Committee is selecting subcommittees for the detailed carrying out of the program. The previously mentioned work of the National Academy Committee has been independent of that of the A.I.B.S.

It is the feeling of many physicists and chemists that the basic unity of science, especially in the physical sciences, should be shown in the way the introductory courses are taught. The arbitrary dividing lines should not be heavily drawn, and an integrated course in the physical sciences would make a great deal of sense.

At present, the chemistry course requires a significant amount of physics before it can get started in dealing with the ideas of atoms, molecules, and their interactions. On the other hand, as the P.S.S.C. program shows, one can quite naturally get involved in things chemical when discussing atomic or molecular physics or the nature of crystals. Some people have been giving serious thought to such a course, developing the important aspects of physics and chemistry together over a two-year period. The only serious obstacle is a purely administrative one: what one would do about transferring students.

It should be clear from the list of movements mentioned that there is a joint action on the part of high school and college teachers with careful thought being given to common problems. Help has come from many private foundations, as well as the National Science Foundation. It should be noted in passing that the NSF is so well aware of the particular problem that it has a special division entitled "Course Content Improvement Section" headed by Dr. Arthur S. Roe. This section has provided the necessary encouragement and support for many of the newer programs.

As a result of working with the P.S.S.C., I feel it is the best thing that has happened in the teaching of physics in over 50 years. For the first time, high school and college people are working together on our common problems. It seems clear that this is true in the other programs as well. It is a good and healthy situation and one long overdue.

I have some of the materials of the P.S.S.C. program with me. If any of you care to look at them afterward, I would be glad to show them to you. The collateral references which I said were needed so badly are beginning to appear. Three titles are currently available. By next summer, there should be about five or six. One is on magnets, with the subtitle, "The Education of a Physicist", by Dean Frances Bitter of MIT. There is one on "Soap Bubbles and the Forces Which Mould Them", which is interesting since it was written before the turn of the century and still stands as a good reference. It is a classic and is beautiful material for reference at this level. I think the original publication date was somewhere in the 1880's. The third one is called "The Neutron Story" by Donald Hughes, whom you may recognize as one of the authorities in the work on neutron physics.

The text itself has appeared in four parts, which are referred to as four "volumes". I think that the word "volumes" has an appalling sound, but it really isn't as long as it might sound. There has been continual work of the committee on this count to reduce to a minimum what is required to tell the story and at the same time to tell the story in a coherent way.

In addition, there is a laboratory guide. I have just a couple of them here. There are now four. The teacher's guide is perhaps the one which may startle you. This is one of the smaller parts of the teacher's guide. (Indicating) This is the part developed for the first volume. The other two presently in existence are larger than this.

I think the work of the Physical Science Study Committee does reflect careful and able work on the part of people who know what they are talking about in a particular field of specialization. These are people who are also able enough in the broader sense to talk with those who face the problems of teaching this information. I feel this is a very exciting program. One is continually impressed by the impact it has on the students and the way in which the students seem to get the flavor of what you do when you do science. You do not just talk about it nor believe science is a body of facts which are issued by some oracle in a white coat. Thank you.

CHAIRMAN COLADARCI: Thank you, Dr. Davis. Do we have any questions?

DR. JOHN C. GOWAN (Associate Professor of Education, San Fernando Valley State College, Northridge, California): I think many would like to know the publisher's address.

DR. DAVIS: There is a very serious problem here, as all of you know, in that the adoption of textbooks for a course in most school systems is something that is a four or five year business. The problem arises from the fact that this course is not one that has been developed. It is one that is still in the process of being developed. As a matter of fact, one of the things I have here is evidence of this. (Indicating) This is the first of the four volumes. This other booklet is the revision of about half of it, which appeared this year - the result of the schools' first year of work.

The answer to your question is that the group has now become incorporated under Educational Services Incorporated, with the P.S.S.C. as a subdivision of this. Until the book appears in hard covers (which they expect to be about the fall of 1960), the material will be essentially in the form I have indicated with the revisions appearing in small paper-bound form. One can obtain these materials from the P.S.S.C. Their address is 164 Main Street, Watertown, Massachusetts. I do not know what the prices are. I think originally they were charging something like two dollars for each of these quarters of the text. It is intended that the eventual cost will be five or six dollars, which will be in the same range as most textbooks now. There is also the laboratory guide material and the teacher's guide. The material in the teacher's guide is available only to those teachers that are taking the institutes on this course.

CHAIRMAN COLADARCI: Are there any other questions for Dr. Davis or for any of the speakers?

DR. JACK WILSON (Professor of Mathematics, San Francisco State College, San Francisco, California): I have a question for Mr. Rourke. You mentioned something about the teaching of patterns in the elementary grades. Many elementary teachers seem to have become somewhat fascinated by Dr. Gattegno and his method of teaching arithmetic. Would you care to react to this method of teaching arithmetic? That is my first question.

The other question is unrelated to it. In the publications of the Yale Study Group, they are now insisting that the word "equal" be used in the sense of "is identical to", whereas the Commission has not favored this approach yet, and thus is not using the word "congruent" in the same sense. I wonder if you would care to react to that.

MR. ROURKE: I think it would be very inappropriate for me to react to your first statement about Dr. Gattegno. I have had no experience whatever teaching grades one through seven. I think it would be better if you were to ask someone who is an expert in this field.

Next, with regard to the use of "equal" and "congruent", neither the School Mathematics Study Group nor the Commission is insisting on anything. It is true that on the surface, there are some differences of opinion on what should be done in geometry. The simple fact is that neither of us knows what is best. The Commission has taken one stand - to modify Euclidean geometry, to repair it where we can, and to be honest about it where we can't. The School Mathematics Study Group is a little more optimistic about the possibilities of axiomatic synthetic geometry than is the Commission. We do not suggest the distinctions that they make in connection with the words "equal" and "congruent". But we should have no objection whatever if someone finds such distinctions useful in high school geometry. There are many roads that lead to Rome.

(The morning session was recessed at 12:15 p.m.)

AFTERNOON SESSION

The meeting was reconvened at 1:45 o'clock, Chairman Coladarci presiding.

CHAIRMAN COLADARCI: Between the ending of the morning session and the beginning of lunch, there were a couple of comments to the effect that there hasn't been an unintelligent word spoken so far. These remarks were rather sincerely made. In many ways, this is not only an important evaluation of the morning but also a prediction of the afternoon. If these two people let us down, the blame is all theirs.

While I now give them time to think of something to say, I might report a little bit of interesting intelligence. It involves one of the ex-key figures in ETS, John Caffrey, whom you all know. John is now Director of Research in the Palo Alto Schools. He is partial to IBM equipment, as you probably know. One of the things John has done is to reduce reporting to parents to a punchcard operation. Now, at the reporting period, parents in Palo Alto receive a little card with holes punched in it and various esoteric symbols. The first time he tried it out, apparently, many of the parents were confused. The holes happened to fall in the wrong places. The whole point of the story, as a colleague observed at a meeting the other day, is that the machines are really taking over. They are being treated as human beings. We have, as an example, the letter of instructions which John Caffrey sent out to parents with the last report card. It included the statement: "Pay no attention to the holes punched in the card. They interest only the machine." If John looks rather strange to you these days, you will know that his social interaction is a little bit different from that of most of us.

As you can see by the titles, the two people we have this afternoon are administrators. They are vice-presidents of this organization or of its various relatives. This morning we had an administrator also. We know Dr. Tyler is a human being, however, so we can forgive him. I note this only to pass on another little story. Someone, at a recent conference, observed very pompously that George Washington could broadjump 23 feet. A participant immediately responded, "That's nothing at all. Any administrator can sidestep twice that distance." This anecdote, however, does not approach the infamy of another report which I really saw recently. A report on administration had, as its first conclusion: "The data herein reported suggests that there are three types of schools: large, middle-sized, and small." With research such as this, we are bound to improve.

The speakers this afternoon are in a sense trying to relate the ideas suggested this morning to the concerns of an organization interested essentially in test development. This is a difficult task because it involves, on the part of each of them, an attempt to predict what was said; they had to formulate their remarks before they came. Those of you who have attended these meetings through the years will remember that one of the best chairmen in the world is Welty Lefever. Some years ago, on a similar occasion, he had to summarize the comments of various speakers. He said, at that time, that he wished he had the skill of a particular dinosaur. This dinosaur had two brains: one in the cranium and one in the pelvic region. As Welty said, the dinosaur could therefore think both a priori and a posteriori at the same time. The next two speakers would wish to have such an attribute.

The first of our two speakers is Mr. Kendrick. His initials are S. A. I have been told by everybody in this organization that I should tell you that the S stands for Shildrick. It's supposed to be very funny, but apparently it's not.

He is College Entrance Examination Board Vice-President of Examinations and Research, as the program indicates. He is from Louisiana, by origin, and he apparently admits it. Mr. Kendrick was educated most recently at Harvard School of Education. Before that, he was at George Peabody; and before that, at Northwestern State College, Louisiana. Is that correct? Is there such a place?

Among his other professional activities, he has been Counseling Psychologist at the Counseling Center at Vanderbilt, a member of the Harvard Business School admissions staff, Assistant to the Dean of the Graduate School of Education at Harvard, and Director of Publications for the Commission on Teacher Education of the NEA. He has been with the College Board since 1955, as Vice-President. He modestly says that he has published "very scattered pieces in journals and magazines", and he has been editor of two journals: "The Harvard Education Review", and more recently, "The Journal of Teacher Education of the NEA."

He is going to talk to the point of changes in measurement that seem to follow from the changes in curriculum that were suggested this morning. Mr. Kendrick!

CHANGES IN MEASUREMENT AS A RESULT OF CURRICULUM DEVELOPMENTS

S.A. KENDRICK

Considering the problem he had with "Joe", I am surprised that he can pronounce Shildrick.

I know the morning program has sufficiently established the fact that the curriculum of the American school is in a state of tension. I admired Dr. Tyler's paper very much. My only thought was that I wish I could believe that this kind of thinking about curriculum is likely to be that which determines the curriculum in the secondary school during the next ten years. I think there is a possibility that some alternative forces will be at work. It is necessary, therefore, for me to review them before I begin to talk about my subject, which is "Changes in Measurement as a Result of Curriculum Developments".

I might say that I am going to restrict myself to measurement when it comes from outside the school and is at least partially coercive. By that, I mean that the test selection is not in the hands of the school. I use such a narrow definition for my paper because I think this is the area in which the most critical point of articulation of measurement and curriculum occurs. If you can choose your own tests and your own curriculum, obviously changes depend upon your own ability and the availability of instruments. When you are confronted with something like the College Board, or in New York State with the Regents; or scholarship examinations, National Merit, General Motors, California State, you certainly are not in the same position to make the neat fit that is theoretically desirable. I think that I have chosen the hard part of this assignment. It is this difficult aspect that I shall talk about after I have reviewed another way of looking at the current curricular struggle.

First, I wish to comment about the words "test" and "examinations" and their meanings for various groups. I have had my head almost torn off by various people for using the word "test" for an essay. Although I thought these were synonyms, I quickly discovered that among certain people in this country, a test is a wicked thing and an examination is a fine thing.

I think that there are about three major groups now contending to shape the curriculum which the secondary school will have beginning some time within the next four or five years. To begin with, there is the conservative position, representing exactly the position dominant in the American school during most of its history up to and through the first two decades of this century. Those of the conservative persuasion have never given ground to the reform movement which came to dominate the talk about education during the 1920's and 1930's. The conservatives emphasize that the school's primary mission is the cultivation of the intellect. They reject or deplore the school's custodial function, scoff at adjustment, especially at life adjustment, and stand strongly for the conventional disciplines, conventionally taught.

The conservatives went out of fashion (but not out of the schools) under the impact of the great depression and the nearly simultaneous discovery that the college preparatory function of the usual high school had become temporarily insignificant when the American people made the secondary school the "common" school of the Twentieth Century. The conservatives were helped out of style by the new educational research and by the philosophical work of Dewey and his allies, but I suspect that the facts of life had doomed them before an opposing rationale had been completely formulated.

The conservatives like examinations but they do not like tests. They welcome the external examiner, but they would prefer that he were not a psychologist; and if he reads examinations by machine, they assume that he is not fit to talk to. The new psychologists, with their incomprehensible demonstrations against transfer of training and their scientific examinations against the older wisdom, were part of the outward show of the movement that pushed the conservatives from their dominant position in secondary education. The conservatives are a part of the great tradition of fine American teaching; but if they prevail, examinations will snuggle in toward evaluation of a limited number of sharply and uniformly defined courses of study. There are worse plans than this.

The conservatives are now resurgent. The times seem ripe for them, what with the Russians, taxes, admirals, and such. Much more important, I think, is the fact that the dynamic force has gone out of the liberal movement, at least for the moment. But the conservative resurgence is strangely sputtering. Opposition has appeared in surprising places, almost amounting to treachery. Eminent mathematicians in institutions of impeccable social standing are endorsing outlandish doctrines. The endorsements being mainly in mathematical notation, it is possible to know only that Euclid is on the point of being denounced.

A former president of Harvard has joined in the fight for high standards, solid subjects, and hard intellectual work; but he has also become a champion of the comprehensive high school, called for a senior course in citizenship to be taken by all, and (perhaps unwittingly) taken a position with respect to the study of languages that threatens the existence of Latin in the secondary school.

The Modern Language Association has understandably set up a proper clamor for foreign languages for all - or almost all; but the Association is now dominated by those who see language more as a tool than as literature and who come with tapes and earphones to mock the language teaching of the past.

There are other examples, but the main point is that the real leadership of what promised to be a conservative resurgence is coming from those whom I shall call modernistic, and who seem at least as interested in reforming the curriculum as in returning it to the solid subjects.

The modernist position on tests is not full-formed, but it seems certain to be eclectic and more favorable than not. The modernist will want examinations as long as the item-analysis (which he generally understands and rather approves) is careful and there is no vendetta against free-response examinations. If he prevails, there will be a great deal of testing of all kinds, but it will be more a part of the machinery and less a great crusade than at some times in the past. There are worse plans than this one, too.

There remain the liberals, grown somewhat older now, but heedless of Shaw's admonition that every successful revolution should conclude with the execution of its leaders. The liberals remain in titular command, but, as I have said earlier, their verve seems weaker. They are not so much in retreat as moving in rather wavering circles. The liberals have the grass-roots control that 30 years in office brings. They also have the usual collection of vulnerable places needing defense, and the really valid original triumphs have become common-place and therefore bring their authors no further credit. Or perhaps the truth is that the liberal movement which did so much for the elementary school never won the high school at all. It shattered the old pattern or presided while the old pattern fell apart, but the liberals never really got what they wanted in the curriculum of the secondary school, and they now must defend what they never fathered.

The liberal likes tests and has always used them. Since he would break down the boundaries between traditional disciplines and talk about learning in new terms, he will, if he prevails, use a great many tests. These tests will be mainly or entirely objective and will be worked closely into the educational process, though not into the customary divisions of learning. The liberal rather distrusts uniformity and the external examiner, and will therefore multiply tests even more. For a third time, there have been worse ways than this of conducting a system of education.

Now, you and I and a few others who are not able to be here today are above such classifications and partisan division. But our colleagues are not (and they are numerous) and will sooner or later determine the curricular issues of our time in education. I do not know how matters will be decided - probably, as usual, by some accommodation among the three schools of thought; but I do believe that before some new uneasy consensus is reached, there is a possibility that significant numbers of schools, states, or even regions will adopt equally rational but plainly divergent curricula. At that thought, for those who work with national testing programs, as the poet has it, "all roads are exceedingly flat, and all hair stands on end."

I am concerned here, as my assignment implies, only with tests which stand in some direct relationship to the curriculum. I am also mainly concerned with tests which are at least partially controlled from outside the individual school. I think I have explained why.

The technical problem in this situation is reasonably easy to state. Ideally, a test which purports to measure formal learning in school should be based directly upon the curriculum studied in the particular school or upon a curriculum decreed by appropriate outside authority and ignored by the school only at its peril. The second of these alternatives, the existence of a coercive national authority, has not been possible for a long time in the United States, and I hope and expect that it will not become possible. The first alternative, basing the test upon the curriculum voluntarily chosen by the school, is obviously out of the question unless there is a reasonably good national consensus with respect to the curriculum. When there is such reasonable consensus about at least a substantial central core, local differences can be expected to cancel out to the detriment of no one if the test is made long enough, samples are broadly in the material within which consensus has been reached, and if the test is constantly scrutinized by persons who are in close touch with teaching in the schools.

The College Board's test in the social studies is an example of testing in an area where there is some, but not perfect, consensus. There is a long-standing quarrel between the historians who would have the schools teach nothing but history (with perhaps some government, if suitably historical) and those who have wanted to break down this conventional sequence and teach citizenship, internationalism, geography, anthropology, and a great many other units and topics that do not normally occur in conventional history courses. By and large, the historians have had their way in independent schools and a few predominantly college preparatory public schools. In most public schools, the broader social studies have prevailed insofar as philosophy and over-all curriculum design are concerned. Still, it has been possible to make a national test because a substantial consensus has remained.

Both camps have agreed that American history is at the heart of high school social studies; and none has objected to testing for ability to read charts, graphs, and maps, to read social studies materials with comprehension, and for understanding of the very largest landmarks in Western history outside the United States, etc.

There has been grumbling on both sides, but the consensus has held and the test has worked rather well. There has been only one major difficulty: As the test has moved more and more into the area of reasoning with social studies materials and reading comprehension in the social studies, its correlation with the verbal score of the Board's Scholastic Aptitude Test has risen. This is not to say that the test therefore has no value (although its usefulness does diminish as the intercorrelations become very high), but it does mean that the propriety of calling this a test of school achievement is no longer entirely clear, especially for a particular school. A second kind of accommodation to diversity among schools is the proliferation of tests. If the failure of schools to reach general agreement about the curriculum involves a division into two or three clearly defined and inclusive groups, it is theoretically possible to issue a test for each group. I say this is theoretically possible because there are only a limited number of such arrangements that any organization can make before communications with consumers break down. The Board would call them clientele, but they are still consumers. Still a certain amount of proliferation is possible, and this is the solution used by the College Board at the present time.

You heard Mr. Davis talk about the PSSC situation in physics. We have solved this division among schools in the teaching of physics momentarily by using two tests. One is adapted to the PSSC course, and one is not, being adapted to conventional physics.

We are about to issue listening comprehension tests in modern languages as optional tests for those schools that teach by the direct method in French, German, and Spanish. We have long offered two different tests in Greek for a total of 50 to 60 students a year, some of whom are in Athens.

I will diverge for a moment. A few years ago, we asked a subcommittee of the Trustees to study the problem of the Greek examination, which was attracting less than 50 candidates a year and going downhill. It seemed to stabilize around 30. Ths subcommittee took a year to deliberate and consult people in schools and colleges. They came back to report triumphantly to the Trustees that not only should we not abandon the existing Greek test, but they thought it was perfectly preposterous to have only one test. There ought to be both demotic and Homeric Greek. Therefore, we had two Greek tests the next year. This is one problem, you see, of conducting a national program for which "Fair for all" is the slogan. The proliferation of tests, then, is a partial answer, but it is difficult.

The third solution to the problem of diversity (and one which has been very popular with many testing agencies) is that of making tests which seek to measure abilities that are fundamental to later performance in the subject measured, that can be developed by widely varying but equally excellent teaching techniques and materials, and that are obviously acceptable to teachers of every philosophy. The trick here, of course, is to make good on the words I have used. It usually turns out that when you make an excellent test, it is mainly verbal reasoning and reading comprehension in special fields. Some of the best tests I have seen are based on this rationale, but all of them tend to fall short of the objective. I have already commented that intercorrelations tended to be high among such tests if they are reliable tests and that therefore there is a great deal of uneconomical use of testing time. Indeed, under the strict definition I have given, this kind of a test is more of an evasion than a solution of diversity. I say this without anything at all against the tests for certain purposes, such as college admissions, because it may be that the measurement of these long term outcomes of school experience is a great deal more important than measuring the outcomes of particular courses. You must be very certain you know what you are doing when you take this particular route to solving a problem of diversity.

A fourth method of dealing with increasing diversity in the particular case of college admissions testing is the proliferation not merely of tests but of testing programs and college entrance requirements. This is no solution at all, of course, but merely a warning that if the problem of diversity is not soluble, we might find that colleges will once again lay down very specific requirements with regard to the high school curriculum and will enforce these requirements with tests designed to meet college demands rather than school practices. In a sense, this amounts to the college saying that by cutting itself off from a great part of the population, it can still get what it wants. Therefore, it does so. I don't think this will happen. It would be a calamity to have it happen, and I think we all have better sense; but there will be tendencies toward more specific requirements and less flexibility in colleges as long as the current debate about the curriculum continues to coincide with a seller's market in college admissions. Just last week, one major Eastern university announced that, beginning in 1962, admission will be restricted to students offering at least three years of high school study in a single foreign language. There will be other such announcements. From this position, it is but a step to specifying that competence in listening comprehension, rather than merely in reading the language, must be demonstrated on a test. The number of possible elaborations is immense.

So far I have talked mainly of the solutions available and the difficulties involved in each. Now let me say briefly what has happened and what I expect to see happen.

Very little has actually happened in national programs for testing school achievement. Since World War II, there have been some major improvements and important rethinking of tests offered to schools. I would be an ungrateful guest if I did not say that the STEP series of the Cooperative Test Division is the outstanding example. These do not seem to me to have resulted from reactions to curricular change so much as from a very useful re-analysis of measurement needs that have existed for a long time.

In the College Board program, we have added tests that I mentioned earlier and have made what we believe to be improvements in existing tests, but again not in response to particular changes in the curriculum, except for the additions to programs. We have added two questions on modern mathematics to the total of 50 questions in the higher level of our two achievement tests in mathematics. This is not enough to affect any student's score significantly, but we would not be sorry to hear that it attracted the attention of a few teachers and administrators. We have experimented interminably with the English test. This is not because of changes in the curriculum but rather because a curriculum in English does not exist.

The future seems a good deal more exciting, if less certain. First of all, the gross splintering of the curriculum that I postulated earlier may not happen. Rather, schools will have somewhat less freedom to go their own way than they have had before. I doubt that the tighter controls will come from testing agencies except as a secondary response to the things schools themselves are doing. The controls are more apt to come from within the schools themselves or, if not, from the public and the colleges.

Actually, I see all too little rather than too much resistance to the dominant trend at the present time. It is becoming increasingly easy to solve public relations problems by hasty adjustments of the curriculum to implement the Conant Report, or the recommendations of the College Board Commission on Mathematics, or some other especially noticeable recommendation for change. Almost any superintendent can buy a semester or so of relative peace by finding someone to speak French to the fourth grade for 20 minutes a day. I deplore not the teaching of

French in the fourth grade but the fact that some of us are going along with the tide very easily. In any event, I expect somewhat greater uniformity in school practices to reduce some of the problems that could result from a period of curricular reform.

Secondly, there will be even more tests, including, I am afraid, tests thrust upon the schools by outside agencies under circumstances not within the schools' control. As one such outside agency, the College Board is greatly aware of the growing burdens imposed upon schools. We hope to control our own contribution to this burden; but if the curriculum fragments, the pressure for new tests and therefore new testing occasions will increase.

Finally, if schools do adopt many very different kinds of programs or if colleges regress to the kinds of entrance requirements that were familiar in the 1920's or the kinds of testing that were common even earlier, the clear solution for national programs will be to abandon end-of-course achievement testing and develop the kind of comprehensive half-way house between aptitude and achievement which measures the long-term fundamental outcomes of learning over many years but does not attempt to fit itself to the specific aims of short-term instruction. In fact, the College Board at least is making such a test to show around in 1959-60, merely as a subject for conversation. In spite of my earlier remarks about such tests, this will not be a bad solution if we have to come to it.

I have one final word which has nothing to do with measurement, perhaps, or with tests that are in development or in existence. I think that however things come out, the strain upon the expertness of guidance workers and testing people generally is going to be enormous. As the curricula become more complicated, the more complex will be the college admissions requirements, and the anxiety of both students and parents will mount about these outside testing programs, and the more knowledge guidance and testing people and instructors are going to need.

Your chairman mentioned this morning the man who didn't want to interpose the test between himself and the child. Well, I know his older brother. He is the fellow who is willing to accept the test but learned long ago that you have to interpret it with caution. For a long time, I felt that by interpreting with caution, people meant what I mean when I say you must interpret tests in context. I learned that this isn't true. The term too often means that since you don't really know too much about the testing business, when a decision comes up there are two possible courses of action: (1) You cannot make the decision and let something happen beyond your control; (2) You can make the decision, go home, and lose sleep all night. This is being cautious. This isn't what we want for the children that must find their way through the possible maze of testing, requirements, and curricular change that the next ten years could bring and, I think, will bring.

CHAIRMAN COLADARCI: Thank you, Mr. Kendrick.

Robert L. Ebel is Vice-President of Testing Programs and Services at ETS. He has responsibility for test development, administration, analysis, and direction of programs, a role he has held since 1957. He was at the State University of Iowa, where he was Professor of Education, Director of the University Examination Service, and also Director of the Bureau of Education Research. There is an old

Japanese saying which translates freely into something like this: "A frog at the bottom of a well cannot know the ocean." Dr. Ebel denies the validity of that generalization, because he was born and raised at the bottom of the well. I see he was born in Iowa and went to public schools there. You know what Iowa is. It's the place where all tests are standardized. He took his B.A. at the Iowa State Teachers College, his M.A. at the State University of Iowa, and his Ph.D. at the State University of Iowa. ETS rescued him from that state in 1957.

Despite this impoverished experience, he has amassed considerable breadth, learning, and intelligence. The Japanese are going to be disappointed to learn that one of their propositions does not have as much validity as they thought it might. He is a member of the NEA, the American Psychological Association, the American Association for the Advancement of Science, and the Psychometric Society. He is Past President of the National Council on Measurements Used in Education and a member of the Executive Committee of the American Educational Research Association. He is author, as I am sure you know, of several tests, and a prolific contributor to the research literature on test construction.

He is going to speak on "Judging the Usefulness of a Test in Curriculum Measurement". I had a chance to read his paper a few days ago. Although I understand he has made some changes in it since, I was quite impressed with it. Dr. Ebel will assume the aggressive stance which Mr. Kendrick has already taken. What he is going to say he really means; and I understand from his friends that when he really means something, he says it rather strongly. Dr. Ebel!

JUDGING THE USEFULNESS OF A TEST IN CURRICULUM MEASUREMENT

ROBERT L. EBEL

I am sure that by this time you all appreciate the problems of a speaker following an introduction by Professor Coladarci. I hadn't gotten well acquainted with him until last evening. But as soon as I did, I began to sense what the problems might be and took counsel with myself as to how I should proceed. I realized very soon that there would be no point in trying to trade quips with him. He is far too bright for that. Since I was last on the program, it occurred to me that I might try kindness. I have done so assiduously, and you see the results. I didn't even have to take any special measures to get his attention.

There is one thing I have noticed about Professor Coladarci that may have escaped you. He is essentially a modest man. In fact, he likes being modest so much that he would see everyone else in this state of grace if it were possible. He has developed some very effective techniques to unstuff the shirts and let the air out of inflated egos.

I think I can illustrate his essential modesty by relating a story which he will deny. Pay no attention to the denial. A short while back, he was delivering a speech and was the victim of a very effusive introduction. As a matter of fact, the introducer wound up by saying, "Ladies and gentlemen, I give you one of the world's truly great educators." Exhibiting this trait of essential modesty, Professor Coladarci's first remarks to the audience were to deny this and say that he was not really a great educator but just a teacher and an ordinary individual.

His speech went very well. The audience responded graciously, and he left the hall with his wife feeling euphoric. The statement that the chairman had made in introducing him stuck in his mind. Half absentmindedly, he said to his wife, "Dear, how many truly great educators do you suppose there are in the world?" She was silent for a moment and said, "Arthur, I really don't know. But I suspect it may be one less than you think."

Reference has been made to the problems of communication that the speakers on this program might have. There was a brief quotation from a poem about the dinosaur and his two brains. This reminded me of another poem which may be appropriate here.

> I had a little dachshund once,
> So long he had no notion
> Of the time it took his head to notify
> His tail of its emotion.
> And thus it was that when his head
> Was hanging low in sadness,
> His little tail kept wagging on
> Because of previous gladness.

If my comments this afternoon seem out of harmony with the wisdom that was expressed here this morning about curriculum, please remember that this panel had communication problems too.

I am delighted to have this opportunity to talk to you about the quality of tests and the effective use of tests. I should make it clear that I am not attempting to present any ETS point of view. I doubt if there is an ETS point of view on this subject. If there is, I haven't discovered it. We all are working toward the same goals, but we think we see different paths toward them. I would get a very vigorous argument from some of my colleagues on certain positions that I propose to take.

Let me begin by referring back to the topic and elaborating on it a little. The topic is "Judging the Usefulness of a Test in Curriculum Measurement". There are two general questions which need to be asked in judging the usefulness of an educational test. The first is: To what extent does the test reveal the achievement of important educational objectives? The second is: How accurately does the test distinguish between students having different degrees of this achievement?

The first question relates to the relevance of the tasks included in the tests. The second relates to the reliability of the scores. Together they provide a basis for judging the validity of the test. It is generally agreed that validity is the most important characteristic of a test.

To judge the relevance of the tasks in a test, one must first determine what the important educational objectives are. Then one must decide how the extent of there are non-intellective components in college performance. We have invited people to show us research proposals which we might support. We have gotten a large number of proposals. The last group of them went something like this: "I don't have much else to do next year. Why don't I give some tests and then rummage around for a factor analysis?" We have not supported those. We have gotten some fairly interesting proposals under way. Very few of them are complete.

Pace and Stern at Syracuse have taken the Murray "need-press" approach to individual personality and turned it around upon the institution. They developed a college activity index which attempts to demonstrate what the college environment does and how it fits with the needs of the individual. Their first effort with this was very impressive, so impressive that someone else gave them more money to continue this work.

This is one aspect of the thing. It is the non-intellective variable in the environment instead of in the individual.

Anastasi at Fordham is still working on a biographical inventory. I know that biographical inventories have been tried time and again. She is making an all-out attempt with some very promising data. If nothing comes of it, we can at least say that a top person with lots of data did it. I think there is a chance we might find something out there.

We have a number of other projects of this sort in the works. Only one test is in sight; that is one by Professor Schlesser at Colgate, who has published in various places about a test that he has constructed on a questionnaire-type form which, astonishingly enough, keeps giving good results in that it doesn't correlate much with scholastic aptitude tests and is on a par with college grades. He sent data to our research committee, a distinguished body of people. Their comment was, "This is astonishing. However, one must either question his integrity, his arithmetic, or suggest that perhaps he has something." We have a lot of money tied up in it. I am still skeptical, but not of either of the first two factors I mentioned.

We run across the fact that to evaluate non-intellective matters in the adolescent personality or whatever, you most frequently have to ask him to be candid about himself. Any youngster who would be candid to a college admissions officer when he is trying to get in probably isn't intellectually capable of making the grade.

CHAIRMAN COLADARCI: I think this is the time to draw this to a close. It's always good to be able to say of a conference that we had to stop the questions.

I'd like to make a few comments. First, I want to say that I sincerely believe that today's experience is a very unusual kind of experience in professional education. We have had five extremely competent people with something to say and a willingness to say it. This doesn't always happen. There is usually one in the crowd who came to lunch. I was really quite impressed. I feel honored to have let my modesty interrelate the five.

There is one more thing which needs saying. Each one of these persons has preabout students who are over-achievers or under-achievers, using only the information that formerly went into the achievement quotients. Although we can talk about the concept of educational potential, caution and soul-searching are most appropriate when one is entertaining the concept. In short, I do not think that educational potential is an entity which can be precisely measured at this time.

MR. DAVID KEIRSEY (District Psychologist, Covina School District, Covina, California): I would like to ask Dr. Ebel a question. If I have not fully formulated it, I hope your intuition will tell you what I am asking. In undercutting and even dropping the anchor of prediction, addressing the question of description, and then keeping in mind Guilford's matrix, what progress has been made in developing tests of ability or achievement which specifically and consciously attempt to describe what the child is able to do, not trying to find out what he will be able to do?

DR. EBEL: I think most of our progress in testing has been in the development of tests which describe what an individual is able to do here and now. By looking at the educational achievement test, you can form a pretty good picture of what it is that the student is being asked to do and what a high score means.

You can get into all sorts of trouble when you ask the question, "But what does this test really measure? The student is answering a question on a reading paragraph, but what does this really measure? Is it really a measure of understanding, or is it really a measure of appreciation, or is it really a measure of something else?" We have invented all of these words without defining any of them very precisely. I think we would be much farther ahead if we stopped worrying about these hypothetical traits that are supposed to determine the measure and take pretty much at face value the tasks that we set before the youngster.

This is quite at variance with the factor analytic approach to the analysis of human traits and abilities. The factor analyst doesn't undertake to tell by looking at the test questions what he is measuring. Instead, he studies the correlations among lots of different kinds of tests and looks for common causative agents or factors. I would like to point out that you still are faced with the problem of naming the factors after they are discovered. To do this, you must look to see what the test seems to require the student to do.

In answer to the part of your question about how much progress we have made, I would say that we have made enough progress to be proud of it but not enough so that we can quit working. There is still a lot to be done in measuring current status. This seems to me to be very important.

DR. JOHN C. GOWAN (Associate Professor of Education, San Fernando Valley State College, Northridge, California): The discrepancy between College Board exams and later performance in college, when it occurs, has often been ascribed to non-intellective personality factors. I understand the College Board people and the ETS people are working on this. Can you give us some description of what has come out of this study?

DR. KENDRICK: I am speaking for the College Board now. Some years ago, we announced that we were interested in this. It seems reasonable to expect that

The second part of the question concerns what the ultimate psychological effect upon the child will be as opposed to the waste of his educational opportunities. There I am skeptical. I know of no evidence and certainly cannot believe that repeatedly taking tests (unless they are terribly bad tests) can have any ultimate effect that we wouldn't want. Actually, most students enjoy testing if the test is not completely absurd.

DR. EBEL: I might add just a brief comment. I agree with what Sam has said, particularly the second part. I do not disagree with the first part, but I am particularly concerned with this matter of what we might be doing somehow to the child's education or to his psyche by testing him all the time.

The children that I have observed going through this testing process take a fairly realistic and balanced attitude toward it. I am very much impressed by how much they seem to learn simply as a result of having taken the test. One of my colleagues at the University of Iowa, Professor James Stroud, whose book on educational psychology some of you may know, has made the assertion that minute for minute, the time a student takes in working on a well-constructed educational achievement test is probably the most valuable educational time he spends. Those of you who watch students working on tests that mean something to them realize how much their total attention is concerned with the task at hand. If it is a good test, you realize, too, how much practice they are getting in the utilization of knowledge. If it is a bad test, obviously, it is harmful. But if it is well constructed, it falls in the category, it seems to me, of an extremely useful experience. It can be an extremely useful exercise that actually develops education rather than interfering with it.

MR. ALEX D. ALOIA (Associate Professor of Education, Director of Guidance Center, Loyola University, Los Angeles, California): Dr. Ebel used the word "potential". I wonder if we are right in this interpretation of the tests, saying that a student has an intellectual potential or an educational potential. What do they have when we get through with most of our testing? I know I use the word "potential" until I am blue in the face. Are we simply saying that the student performed well in behavior on this particular item? Would you comment on that particular line?

DR. EBEL: I perhaps tripped in using the word "potential" because it is not a very important element in my conceptual scheme. I am much more interested in the interpretation of a test score which says "This is how he performed on this date on these particular tests." What we know about the actual achievement of individuals does not bear out, it seems to me, the notion that we can determine the ceiling on a child's potential achievement by some sort of testing. This can get another riproaring argument started, I am sure. It has to do with the idea of over- and underachievement, and the notion of achievement quotients. To determine achievement quotients, a student is given one test in which he has to work a number of problems and solve verbal analogies so that we can predict how he will perform on an achievement test that also involves a number of problems, the use of words, and things of that sort. This idea was pretty thoroughly discredited as it applies to achievement quotients, but the same notion keeps creeping in the back door when we talk a development of the individual, the less concerned you are with prediction and the more concerned with obtaining a description of what the individual is here and now as a basis for determining what future steps ought to be taken.

I see situations in which prediction is properly the primary concern in the use of tests; but I see many more situations in which the validity of our tests ought to be determined irrespective of what they predict, where it seems to me that prediction is not the relevant consideration. Indeed, even in college admissions, it is possible to take the position that what we ought to be attempting is not to pick out those students who are going to do best in the curriculum as it now exists but to pick out individuals whose educational development has proceeded to the point that makes them good college material. Then, if they don't succeed in college, you do not blame the tests necessarily. You can take a look at what is happening to the students in college. You will look to see if there is some way that this good material is being wasted.

I think I would sum it up by saying that prediction, as an aspect of psychological measurement, has been considerably overemphasized to the neglect of some of these other aspects.

CHAIRMAN COLADARCI: Thank you sir.

MR. DAVID YOUNG (Director of Studies, Happy Valley School, Ojai, California): I would like to ask what happens to the student who is always being tested? Perhaps he is an average student. Are you discovering anything about the students who are forever being tested? I mean, what is happening to his education? I think Bernard Shaw once bragged that he had never taken an examination in his life. The opposite, perhaps, is happening to some of our students. As it was threatened from the platform, we are going to have more and more tests. I wonder what the outcome of all this is going to be.

CHAIRMAN COLADARCI: Whom are you challenging?

DR. KENDRICK: I'd be glad to comment on this. To the extent that all this testing duplicates itself, it wastes school time and is becoming more and more a serious waste of school time. I am frequently asked why the College Board, for example, doesn't get together with somebody or other and agree to have only one test. The only possible answer is that after having tried to do this repeatedly with various school groups, we usually run into the fact that the only way to get one test is for somebody to go out of business. Our trustees aren't ready to, and other people's trustees aren't ready to.

I think the clamor that the schools are very properly setting up is reaching the ears of people. There are some cases where schools can control these matters. Schools in many areas control quite effectively the old habit of every firm in town wanting to conduct an essay contest and giving out a ten dollar prize. I remember when this sort of thing was rampant, and I remember some school principals that handled it. Many of the pressures on the individual schools cannot be handled right now, and there is going to be a lot of wasted time.

The results are beginning to come in. These students have moved on to senior high school. We have a few tear-jerking cases, a few dramatic cases. There was a boy who had a measured IQ of 72 who is now a senior in high school with a good strong academic record in a college preparatory program in spite of the fact that when he goes home at night, his father almost invariably throws his books out the window.

There is a real area for work here. As far as I am concerned, there is a great deal that can be done. If the schools are any good at all, the only place where there should be undiscovered talent in the junior high school years is in the slums. There may be a lot of it there. No one knows.

CHAIRMAN COLADARCI: Does anyone want to ask Dr. Kendrick to elaborate on the distinction between a Broadway play and a Princeton football game? It is an item from the Wechsler-Bellevue, I think.

Are there any other questions? I am rather surprised that you would let Dr. Ebel get away with his rather cursory dismissal of prediction as a useful concept in talking about criterion problems.

DR. EBEL: Would you like me to speak about that?

CHAIRMAN COLADARCI: Yes. Before you do, may I ask the question? There's one thing about ETS people - they can answer a question before it is asked. Then, they deny the relevancy of the question you would have asked.

You will recall Dr. Ebel asserted that essentially the criterion question for any test is a prediction question. Indeed, some people define the meaning of a test by what it will predict. What is a test for? Let's find out what kind of things it predicts. Cronbach's definition of a validity comes close to this conception. A lot of people dismiss this rather quickly, I think, and I would like to hear you speak a little bit more about it, if you will.

DR. EBEL: I'll be glad to, Art. I certainly didn't mean to dismiss the idea of prediction in all situations. What I intended to do was to try to undercut it a little bit as the only way of determining the validity of a test. I think there are other methods for many educational tests, including achievement tests, and in some cases aptitude tests, which are considerably superior. Here one comes up against a basic difference in point of view towards educational problems. We probably need more research on this, as we do on most of our problems. If we were only smart enough, we could discover the extent to which an individual's success and his educational potential were somehow built into him as a very young child. We might discover the extent to which his educational progress is a predetermined unfolding. Now, the notion of built-in, specific aptitudeis the notion of the child as a highly adaptable, flexible individual who can be guided and trained in various ways. The more emphasis you place on what has been irremedially built into the child and on what is there and has to be accepted, the more likely you are to be concerned with selection purely on the basis of prediction. The more you are concerned with education as a process of (forgive me for using the word) adjustment, some of the achievement tests, there was a mean gain, for a fair-sized group, of about 120 points. The 50 points doesn't worry us too much because of what you have pointed out. Certainly, the 120-point difference can bring into our school some boys who we later feel should not be there.

DR. KENDRICK: I don't know enough. No one knows enough about the effect of a full year on achievement tests. It may be that things that are not learned are reflected on the test. Your 50 points on the aptitude test will happen by growth alone a good part of the time.

DR. JOHN CAFFREY (Director of Research, Palo Alto Unified School District, Palo Alto, California): I would like to ask Dr. Kendrick about the Board's present thinking on the idea of making an attempt to select pupils for college earlier than the twelfth year of high school. What has the progress been, if any, along that line?

DR. KENDRICK: I'm not sure I know, John, whether you are talking about early admission.

DR. CAFFREY: An attempt to select earlier in the school years those pupils who should be guided towards college.

DR. KENDRICK: Well, I don't think we have any novel insight into it. I have always taken the position that there are a number of ways in which talent is selected. If you are talking about students from middle class homes, if the students remain in school for six, seven, or eight years under constant instruction and observation, and if at the end of that time the school doesn't have a pretty good idea about ability to perform, there is something wrong with the school. This is especially true if the school uses the conventional tests that are on the market at reasonable prices to supplement all of the thousands of hours of observation.

There is one particular problem in which I have been very interested. This is the deprived child in the lower class. The Board has been putting a modest amount of money into a project in New York City where we picked up a bunch of kids from Harlem who were of mixed racial origin, including a number of Puerto Ricans who had recently come to this country. We made the assumption that testing them had not revealed anything much about what they might do if they got the proper amounts of instruction, guidance, and help.

We poured in guidance services. In some of your better school systems, you wouldn't think we poured them in. In the junior high school, where we began with a ratio of 2,000 students to one counselor, we reduced it to the ratio of 350 to one. We put in a great many remedial reading teachers, remedial arithmetic teachers, and we put a social worker on the case. We reduced class size; and we took them to everything from the Metropolitan Opera to Broadway plays, the Princeton football game, and anything that would get them out of the environment in which they were then concentrating.

Cadet Registrar, U. S. Air Force Academy, Colorado): I would like to address a question to Dr. Kendrick. As a user of tests, I am concerned with a particular kind of curriculum that is present. It is probably a problem to you. Certainly, it is a problem to us as one of your clients. What, if anything, does the College Board try to do to reduce the effect of special prepping? We believe, from data we have and that which we have seen from other schools, that some of the usefulness of the College Board tests in predicting college success has been reduced greatly by the so-called prep schools which have been teaching essentially for the exam.

DR. KENDRICK: We have been concerned with this for five years at least. We have conducted three intensive attempts to coach students for the Scholastic Aptitude Test. We have invariably failed, although we have tried with more intensity than is usual in any coaching school, with the possible exception of some military academies with a full year of prep schooling where one gets into the logical problem of whether a year of coaching or maturity makes the difference.

People don't believe this. We keep telling them and showing them that every time anyone has data, we are glad to try to analyze them with the particular institution. We invited a New York City school principal who wouldn't believe it to do something with his own people. He divided his junior and senior high school class into three groups: one went to commercial coaching schools in the city, one was coached at the school by the faculty, and one had nothing at all. It was quite carefully checked. At the end of the year, the gains on the Scholastic Aptitude Test were identical in the three groups - the means were identical. There were three cases in the whole student body of gains of 100 points on the test. One was in the commercially coached group, one in the school coached group, and one in the group that had nothing at all.

We have done this four times and are perfectly prepared to stand on the fact that no method we are able to devise or discover abroad is changing scholastic aptitude tests to a degree which will make differences in college admittance. There are some niceties here. If a student is not taking mathematics in the senior year, he might get 25 points on a 600-point scale by coaching. He will probably get it if he reviews seventh grade arithmetic.

When you get into the achievement tests, things are different. If you coach for an achievement test, what do you do? I assume you try to teach the subject. You do or you don't. There are logical problems. The essential issue is, "Is rote drill on test items the best way to teach mathematics?" I think it is not. If it is not, the time for coaching would be more wisely used with a better pedagogical method. If it is, good. That's the best answer I can give you.

CHAIRMAN COLADARCI: Is that responsive to your question?

MR. WESTEN: Yes, I think that's a fine answer. I presume I may have biased data from a group of people who have attended a full year prep course for military academy. We found an average gain of close to 50 points on the aptitude tests. On and permit more accurate measurement. This begins to sound very much like the procedure for building a better test. We began trying to improve tests by improving criteria and find that the only way to improve criteria is by improving the tests.

The emphasis some test specialists place on prediction, on correlation coefficients, and on empirical statistical procedures reflects a mistrust of human judgment, even expert judgment, in determining what a test should measure or in telling what it actually does measure. Some of these specialists approach the test construction task as if the highest praise for their work would be to say, "He used absolutely no judgment at all, either his own or anyone else's in constructing this test."

No informed or reasonable person would argue that judgment is infallible, or that empirical, statistical evidence of validity is irrelevant. But neither should one argue that human judgments are completely untrustworthy, and that the only dependable evidence of test validity is provided by a correlation coefficient between test scores and criterion measures. Ultimately we cannot escape the process of judgment in determining what we should try to measure or predict. We cannot escape the process of judgment in deciding what to call the thing we have measured. There is no purely statistical process that can tell us which elements should be included and which excluded when a named trait or area of achievement is being defined, or what we have measured when the test has been constructed and given. Statistical evidence, reduced to correlation coefficients, can help us to avoid the jingle fallacy (calling different things by the same name, and henceforth assuming that they are the same), or the jangle fallacy (calling the same thing by different names, and henceforth assuming that they are different). Empirical evidence can confirm or refute our judgments but cannot replace them. The judgments of experts and the data from experiments are both essential in test validation.

On the whole, classroom teachers have been far too little concerned with judging the usefulness of their tests, either those they buy from test publishers or those they create themselves. Much can be done to improve this situation by giving greater attention to the questions of what is to be measured, and how it is to be measured, and to an analysis of the quality of the test after it has been given. Cooperative test construction, in which each participating instructor must examine his own ideas and be prepared to defend them in comparison with alternative ideas, is one promising approach to more useful tests. The quality of tests a teacher constructs provides revealing evidence as to his competence as a teacher. A good teacher can give poor tests and weaken his educational influence in the process, but a poor teacher, one whose command of subject matter is inadequate, and whose educational values are unsound, cannot possibly construct a good test. Better tests lead to better education. Let us continue our efforts to improve the quality of our classroom tests.

CHAIRMAN COLADARCI: Well, we have finished the formal presentations in good time, so we can consider your questions and reactions at leisure.

RISDON J. WESTEN (Chief, Research Division, Evaluation Directorate, Office of

Does the sacrifice cost more than it is worth? In some cases the answer may be yes. In others it is probably no. Both judgment and experimental evidence are involved in determining the answer.

It is well to remember in this connection that any test is inherently and inescapably artificial. This is a disadvantage of tests, but it is usually more than offset by the advantages of uniform, controlled conditions for the observation of examinee behavior and efficient accurate means for recording that behavior. A test using indirect measurement is more artificial than one using direct measurement. Hence, the difference between tests using direct and indirect measurement is one in degree more than a difference in kind. When we once decide to give a test, instead of observing natural behavior, we have already gone a long way down the road from naturalness to artificiality. To go a few steps further from complex, wordy, practical problems to concise, definite questions on basic or incidental knowledge carries us a little farther away from direct relevance, but it may yield practical advantages which more than offset the apparent loss in relevance.

For these reasons, perhaps, we should say, not "A good test of educational achievement is one which measures as directly as possible as many as possible of the ultimate objectives of instruction in a course," but rather, "A good test of educational achievement is one which reveals as effectively as possible the degree to which a student has attained as many as possible of the ultimate objectives of instruction in the course." In many cases indirect measurement may prove more effective than direct.

In discussing the relevance of the tasks included in the test and the reliability of the scores it yields, we have covered the two important components of test validity. If a test is composed of highly relevant tasks, if it yields highly reliable scores, then it will be a highly valid test. This represents a somewhat different approach to test validity than that taken by many test specialists. It may be worthwhile for us to consider briefly the more conventional formulation of the validity problem and some of the difficulties it leads to.

Many test specialists are persuaded that the only proper way to validate scores on a test is to determine a validity coefficient between scores on the test and some appropriate criterion measures. Whenever they discuss the problem of validity seriously, one of them is sure to suggest that the real source of difficulty is our lack of good criteria, and that the Educational Testing Service or some other agency ought to get to work immediately to improve criterion measures against which the scores of our tests can be validated. This suggestion represents a distinct advance over the naive but widely held notion that teachers' marks or some other conveniently ready-made indices of success, however poorly defined, unreliable, or even irrelevant, constitute perfectly adequate criteria. But still this view reflects a conception of the validity problem which is far too narrow, in my view, and which seems, again in my view, unlikely to lead to significant improvements in test validity.

Efforts to improve the estimation of test validity by improving the criterion lead to a circle which, if not vicious, is at least frustratingly circular; for, to improve the criterion measures, one must define more clearly what is to be measured and control the conditions in which it is measured to exclude irrelevant sources of variation problem of how to measure it. A thorough consideration of this topic would open the door to discussions of tests versus observations of natural behavior, of essay tests versus objective tests, of speed tests versus power tests, of true-false items versus multiple-choice items, and so on. Obviously, we do not have time to consider all of these now. They all have been discussed extensively elsewhere, and while something surely remains to be said about them, I would like to direct your attention to another issue which has not been so widely considered. In the early days of objective testing, short factual test items were in great favor. True-false, completion and matching items were widely used. But attacks on the factual limitations and triviality of many of these questions led to efforts to develop more complex item types which appeared to require reasoning as well as recall. The pendulum of test construction has kept right on swinging away from concise, factual items until now we see some test items intended to measure higher mental processes which seem to be characterized by complexity, verbosity, and obscurity or ambiguity.

For a number of years, teachers have been told that a good test of educational achievement measures as directly as possible as many as possible of the ultimate objectives of instruction in a course. I still like the emphasis on ultimate objectives and upon measuring the achievement of as many of them as possible. But I have begun to have some doubts about the efficiency and necessity of direct measurement.

The difference between direct and indirect measures of educational achievement needs to be explained at this point. A direct measure requires a student to use his knowledge in some practical situation. For example, in a course on educational measurement for teachers, one might ask them to write a good test item, to calculate a standard deviation, to interpret some item analysis data, to justify a guessing correction formula, or to deal with a multitude of other realistic problems that teachers are likely to face in their use of tests. An indirect measure of educational achievement, on the other hand, while it also seeks to identify the students most likely to deal effectively with practical problems such as these, does so, not by presenting the problems themselves, but by testing for basic or even for incidental knowledge which the well-trained student is likely to have acquired.

On the surface, it would seem that direct measures of educational achievement should be clearly superior to indirect measures. They are designed to be as relevant as possible, and relevance is what we are seeking. But unfortunately there are complications in the direct approach. Practical problems are often complex. It is sometimes difficult to write an adequate answer which will withstand critical scrutiny. Efforts to describe the problem situation adequately often result in test items that are wordy and time consuming. The examinee's reading and test-taking skills may become important factors in the score he receives, lowering their validity. Because there are fewer scorable responses per hour of testing time, as well as because of possible ambiguities in the situations and their descriptions, and of possible indeterminancy in the best answers, tests using the direct approach often yield scores of low reliability for the amount of time they take.

The indirect approach sacrifices relevance to gain brevity, clarity and definiteness.

that we may now have an excess of curricular freedom. It is fair to ask whether this freedom and the diversity in course objectives and content which result actually give us a better educational product than would be obtained if efforts were made to establish greater consistency and uniformity in some common core of essential knowledge and skills. The freedom to be different implies the freedom to be worse, as well as a freedom to be better.

If a requirement of greater uniformity in course objectives and content would turn inspirational teachers into drill masters, I would oppose it firmly. But I suspect that the acceptance of more uniform goals and standards might turn some pedagogical dilettantes into more purposeful teachers. Great curricular uniformity would enable us to measure educational achievement more effectively and meaningfully. Wisely administered, it could help reward the superior teacher and make the teaching career a little less attractive and comfortable for one who is incompetent. In short, I wonder if the leaders in the educational profession should be quite as ready as they seem to be to rush to the barricades in defense of the right of each educational institution or of each professor to determine what shall be taught.

The second point concerning what our tests should measure relates to the importance of acquisition of knowledge as an educational objective. The current fashion among educators, and even among test specialists appears to be to deprecate, and possibly to underestimate, the importance of knowledge. Those who spurn knowledge as an important goal of education usually turn to some form of mental development, obscurely defined or undefined. "Teach the students to think," they urge. "Develop their minds." As a human being who believes he spends most of his waking hours thinking, I stand with those who approve of this function, even though it is one in which eggheads and other questionable characters are supposed to excel. But I do not quite see how to separate thinking from knowing. While I am not in favor of stuffing anyone's mind with anything, it does seem at times that all of us could use a bit more solid, accurate information.

When the products of my thinking turn out to be wrong, as sometimes happens, or when my efforts to think produce nothing useful at all, as happens quite often, the fault seems usually traceable to some deficiency in my knowledge. It is possible that some malfunction in my cerebral processes may be a contributing cause. But just what these processes are and how they ought to operate are still very poorly understood even by the specialists. The best way, indeed the only way, I know of teaching students how to think is by giving them command over the largest possible body of the most useful knowledge. Giving them command over knowledge is not the same as teaching them to give back verbatim rote-learned responses. It does involve all these things that we have talked about in terms of ability to use knowledge and understand it. What I am arguing against is the notion that these abilities to use knowledge can be developed apart from knowledge itself. There are no abstract general abilities to think, formulate hypotheses, or to be creative, which are not also closely and intimately related to the knowledge that has to go into these processes.

Having considered briefly the disadvantages of extreme diversity of educational goals and course contents and the importance of knowledge as an educational outcome, let us turn from the problem of what to measure to the equally important achievement of these objectives can be revealed. The first problem, Lindquist[*] has pointed out, ". . . is essentially one of curriculum construction for which the subject-matter expert and the curriculum builder, rather than the test technician or classroom teacher, are primarily responsible, . . ." He continues, "Obviously, until the field of achievement in which measurement is to be attempted has been specifically and authoritatively described, adequate test construction in that field is impossible. It may be noted in this connection that perhaps the most serious of the weaknesses which characterize achievement tests now being constructed are basically weaknesses of the curriculum rather than of the test techniques themselves."

If one accepts Lindquist's analysis, as I do, the number of things a test specialist is entitled to say about what educational tests should attempt to measure is definitely limited. But there are two general points that may be worth brief discussion.

The first relates to the wide diversity in objectives and content of courses bearing the same or closely similar titles. This is particularly true at the college level, and to some extent also at the high school level. Teachers of the same subject have been granted so much freedom to determine what they will teach that something approaching anarchy in goals and achievements throughout the country is the result. It is not at all unusual, for example, to hear a college professor of English literature evaluate a carefully prepared literature test in terms like these: "No doubt this is a very good test, but of course I couldn't use it. It includes many things that I don't teach at all, and omits some things that I stress especially." The fact that the content of the test in question was selected and approved by a group of other eminent professors of English literature does not disturb him at all. As a creative scholar, he feels not only the right, but indeed the obligation, to be unique. Professors in many other fields, and even many high school teachers, react to carefully prepared and authoritatively approved standardized tests in much the same way.

So strong is the typical teacher's faith in the value of his freedom, and so great is his fear that uniform tests will seriously limit his freedom, that many statewide achievement testing programs are maintained only with difficulty. Some have not survived at all. So strong is the resistance to anything that might limit curricular freedom, that the tests used in wide-scale admission and scholarship testing programs must be constructed and presented, not as measures of what the candidate has learned, but primarily as measures of what he is capable of learning. This involves the somewhat surprising assumption that ability to learn is quite independent of previous learning, and that the quality of a student's secondary school education has little to do with his performance on the selection tests, or on his fitness for college.

No one should argue, and I am not arguing, that the absence of local curricular freedom even in high schools would be a good thing. But I would like to suggest

[*] Hawkes, Herbert E., Lindquist, E.F., and Mann, C. R. The Construction and Use of Achievement Examinations. Houghton Mifflin, 1936, p. 17.

sented a kind of analysis that can be described by the adjectives "rigorous" and "systematic". Each statement was one that had been well thought out. It wasn't "off the cuff", and each had something new to say.

These are people who are able and willing to say clearly something they feel strongly, even though they may be at variance with popular notions and current fads and fashions. This is a trait that is infrequent in professional education. We have a very curious notion of professional courtesy in education. It makes it difficult at times for us to say things that someone will find objection to. If it is the "right" thing to say, we say it; if it is the "wrong" thing to say, we say nothing at all, forgetting completely that when the ostrich buries his head in the sand, not only does he present a ridiculous sight, but also a very inviting target.

Another characteristic about all five presentations was that of "boldness". The questions you raised suggest that some of you may disagree, but the frankness of the papers permitted and invited this.

Having read some of the papers before today, I was reminded of the preface to a delightful little book, Bergen Evans' Natural History of Nonsense, which some of you may know. It came out in 1946, and now it is available in a paperback edition. In his introduction, Bergen Evans said something which reminds me of our speakers. He said: "Until about one hundred years ago, rational men lived like spies in enemy country. They never walked abroad unless disguised in irony or allegory. To have revealed their true selves would have been fatal. Today, their status is more that of guerillas. They snipe from cover, ambush stragglers, harass retreating rear guards, cut communications, and now and then execute swift forays against isolated units of the enemy. But they dare not yet risk an open engagement with the main force. They would be massacred. Their life is dangerous but exciting and is warmed by a sense of friendship not often known among the dull conscripts of orthodoxy. This book is intended as a sort of handbook for the young recruits in the gay cause of common sense. It indicates where the main armies of ignorance are now encamped and tells in a secret code what garrisons are undermanned or mutinous. It tries to show the use of covering camouflage and techniques of infiltration and intrigue. It maps roadblocks and minefields and shows how to rig a booby trap. It warns of counter-espionage and it gives, again in code, the five infallible signs to know a fool. When the recruit has finished with it, he can toss it over the wall into the enemy's barracks. It may encourage desertion."

I say very seriously that each of the persons today represents that kind of spirit.

I must say one more thing. One note that has never been made at these conferences, either here at the regional one or at the national one, is something that I think needs noting. ETS is a private organization, but this is an organization that does better the very kind of a thing that a professional organization ought to be doing for itself. Here is an organization whose purpose is to develop tests, and it must exist on its ability to sell tests. On the other hand, it is not merely serving the profession in the commercial sense, but also is taking on a moral responsibility and obligation to educate and be provocative to the profession.

These sessions each year constitute a very important professional experience for people in education. I think it should be noted publicly that this is being done by an organization which is historically the kind of organization which doesn't have this kind of altruism. I am very pleased to note the foregoing because I am not asked to nor am I paid to.

Finally, I wish to make clear what you may have missed. This morning I engaged in some dueling with Mr. Rourke. It wasn't actually dueling, because I seemed to be on the wrong end of the sword. Some of you may have misunderstood this for a discourtesy on my part. Actually we do know each other and we are friends. I admire him greatly. I want to say right now that I think he is a very brilliant man. Indeed, if I were on trial for murder, I can't think of anyone I would rather have to defend me. The only trouble would be that he would have been the victim.

Again, I would like to extend my own personal appreciation and, I am sure, the appreciation of all of you to the people who spoke today: Dr. Tyler, Mr. Rourke, Dr. Davis, Dr. Kendrick, and Dr. Ebel; and also to the Educational Testing Service for what I sincerely consider to be a very valuable contribution to the profession of education.

I think that there is no official benediction; Dr. Helmick refuses to come up before you again, so I will say good-bye on his personal behalf as well.

(The meeting was adjourned at 3:30 p.m.)

CONFERENCE LIST

Jeannette Acrea	Psychologist, Baldwin Park School District, Baldwin Park, California
Fern B. Adams	Consultant, Research and Guidance, Los Angeles County Schools, Los Angeles, California
Georgia Adams	Associate Professor of Education, Los Angeles State College, Los Angeles, California
Lloyd H. Ahlem	Director of Psychological Services, Baldwin Park School District, Baldwin Park, California
Sister Alice Marie	Dean, Mount St. Mary's College, Los Angeles, California
George N. Allebrand	Guidance Director, Los Nietos School District, Los Nietos, California
Alex D. Aloia	Associate Professor of Education, Director of Guidance Center, Loyola University, Los Angeles, California
Harry M. Alter	Assistant Principal and Principal of Summer Session, Beverly Hills High School, Beverly Hills, California
Alvin S. Anderson	Counselor, Mark Keppel High School, Alhambra, California
Charles C. Anderson	Associate Professor, Faculty of Education, University of Alberta, Edmonton, Alberta, Canada
Paul E. Andres	Counselor, Santa Ana College, Santa Ana, California
Melvin A. Angell	Test Officer, Fresno State College, Fresno, California
A. J. Aschenbrenner	Associate Dean, Counseling, California State Polytechnic College, Pomona, California
William C. Atkinson, Jr.	Vice President, Army and Navy Academy, Carlsbad, California
Arthur A. Attwell	Guidance Director, Rosemead School District, Rosemead, California
Olga V. Badeker	Principal, Mark Twain School, Lawndale, California
Lucile B. Bailey	Assistant Principal, Ganesha High School, Pomona, California

Robert E. Barry	Director, Pupil Personnel Services, Santa Barbara City Schools, Santa Barbara, California
Lars Barstad	Curriculum Coordinator, San Luis Obispo City Schools, San Luis Obispo, California
Mark G. Beals	Counselor-Psychometrist, California State Polytechnic College, San Luis Obispo, California
Florence Beard	Headmistress, Girls' Collegiate School, Claremont, California
Edward Bedigan	Principal, Burbank Senior High School, Burbank, California
Robert Bell, Jr.	Director of Guidance, Coalinga-Huron Union Schools, Coalinga, California
Wilson Bell	Administrative Assistant, Education, Paramount Unified School District, Paramount, California
Ernest H. Berg	Counselor, Psychology, Santa Barbara Junior College, Santa Barbara, California
David Bilovsky	Assistant Professor, Los Angeles State College, Department of Education, Los Angeles, California
Frank B. Black	Testing Coordinator, Santa Ana College, Santa Ana, California
Frank R. Blume	Test Supervisor, San Bernardino Valley College, San Bernardino, California
Newman C. Borden	Head, Mathematics Department, Beverly Hills High School, Beverly Hills, California
E. W. Bowes	Senior Statistician, University of California, Office of Relations with Schools, Berkeley, California
Elizabeth H. Brady	Associate Professor, San Fernando Valley State College, Northridge, California
C. Weldon Bramlett	District Psychologist, Whittier Union High School District, Whittier, California
Clara Brees	Director of Guidance Services, Glendale Unified School District, Glendale, California
John H. Bright	Assistant Research Executive, California Teachers Association, San Francisco, California

M. Brocklehurst	Instructor, Department of Education, Los Angeles State College, Los Angeles, California
Barbara Brown	Research Assistant, California Institute of Technology, Pasadena, California
Elma Brown	Supervisor of Guidance, Valley West Elementary District, Los Angeles City Schools, Reseda, California
Hamilton W. Brown	Coordinator of Secondary Education, Pomona Unified Schools, Pomona, California
Quentin R. Bryan	Supervisor of Guidance, Inglewood Unified School District, Inglewood, California
Carl J. Burk	Assistant Superintendent, Instruction, Compton Union High School District, Compton, California
Ann Caffrey	Los Altos, California
John Caffrey	Director of Research, Palo Alto Unified School District, Palo Alto, California
A. M. Caligiuri	Counselor, Los Angeles Valley College, Van Nuys, California
Dorothy N. Candland	Director of Curriculum, Covina School District, Covina, California
Dean Carlton	Director of Instruction, Colton School District, Colton, California
Earl F. Carnes	Associate Professor, University of Southern California, Los Angeles, California
Helen E. Chapin	Coordinator, Burbank Senior High School, Burbank, California
Lois Chappee	Senior Counselor, Glendora High School, Glendora, California
Daria Charles	Vice Principal, El Rancho High School, Pico-Rivera, California
John Chilcott	University of California, Santa Barbara, Goleta, California
Helga Chwang	Secretary - Administrative Assistant, Educational Testing Service, Los Angeles, California
Corabelle Clark	Psychologist, Compton City Schools, Compton, California

Edwin C. Clark	Director of Research, Burbank Unified School District, Burbank, California
Pearl E. Clark	Dean of Guidance, Chaffey College, Ontario, California
Stephen C. Clark	Test Officer, Los Angeles State College, Los Angeles, California
W. H. Clinkenbeard	Assistant Superintendent, Palos Verdes School District, Rolling Hills, California
Arthur Coladarci	Professor of Education and Psychology, Stanford University, Stanford, California
Fred L. Converse	Research Assistant, Educational Testing Service, Los Angeles, California
David W. Cook	Curriculum Evaluator, California State Polytechnic College, San Luis Obispo, California
R. W. Coombs	Director, Research and Guidance, Ventura City Elementary Schools, Ventura, California
Gerald F. Corey	Student, Loyola University, Los Angeles, California
Betty Jane Corwin	Assistant Professor of Education, San Fernando Valley State College, Northridge, California
Raymond Cowles	California Test Bureau, Los Angeles, California
Everett Craven	Dean of Men, Azusa College, Azusa, California
John A. Dahl	Head, Secondary Education Department, Los Angeles State College, Los Angeles, California
Margaret A. Dahl	Student, Los Angeles State College, Los Angeles, California
Kenneth E. Davis	Professor of Physics, Reed College, Portland, Oregon
Margaret Davison	Assistant Superintendent, Education Services, Compton City Schools, Compton, California
Jasper D. DeBruler	Director of Personnel and Administration, 2567th Air Reserve Center, USAF, Van Nuys, California
Elva DeJarnett	Associate Counselor, Azusa College, Azusa, California
Jaclyn K. de Price	Director of Educational Services, Mexico City College, Toluca, Mexico

A. S. Derian	Counselor - Psychometrist, Long Beach City College, Long Beach, California
Elizabeth Dimock	Vice Principal, San Bernardino High School, San Bernardino, California
Mildred Di Paolo	Assistant Superintendent, Instruction, Sunnyvale Schools, Sunnyvale, California
Valeria C. Dotterrer	Counselor, East Los Angeles Junior College, Los Angeles, California
W. L. Downing	Counseling Psychologist, Student Counseling Center, University of California, Los Angeles, California
Evelyn Duncan	Educational Testing Service, Los Angeles, California
James Duncan	Counselor, Riverside City College, Riverside, California
Glenn W. Durflinger	Chairman, Department of Education, University of California at Santa Barbara, Goleta, California
Martin W. Early	Staff Associate, Science Research Associates, Chicago, Illinois
Grace Easton	Head, Scholarship Services Department, Educational Testing Service, Los Angeles, California
Robert L. Ebel	Vice President, Testing Programs and Services, Educational Testing Service, Princeton, New Jersey
Raymond C. Ede	Headmaster, Army-Navy Academy, Carlsbad, California
Stephen W. Eggleston	Counselor, College of the Sequoias, Visalia, California
Celia Einbinder	Secretary, Advisory Services, Educational Testing Service, Los Angeles, California
Glen W. Elliott	Guidance Coordinator, Department of Education, San Diego County Superintendent of Schools Office, San Diego, California
Mrs. Richard Elliott	Director, Desert Sun School, Idyllwild, California
Betty W. Ellis	Supervisor, Research and Vocational Guidance, Los Angeles City Schools, Los Angeles, California
Gladys N. Engelbrecht	Los Angeles State College, Los Angeles, California

James B. Enochs	Dean of Graduate Studies, Los Angeles State College, Los Angeles, California
Howard Evans	Staff Associate, Science Research Associates, Mountain View, California
Harold Farley	Supervisor, State Department of Education, Boise, Idaho
Fenton L. Feeney	Dean of Instruction, Taft College, Taft, California
Helen Fisk	Executive Director, Western Personnel Institute, Pasadena, California
James S. Ford	Director, Test Research and Development, Psychological Services, Inc., Los Angeles, California
Jeannette E. Friedrich	Consultant in Research and Guidance, Los Angeles County Schools, Los Angeles, California
Robert Gale	Principal, Loma Linda School, Loma Linda, California
Paul H. Gardner	Psychologist, Whittier Union High School District, Whittier, California
Jerry C. Garlock	Consultant in Education Research, Los Angeles County Schools, Los Angeles, California
Elsie F. Gibbs	Director, Secondary Education, San Bernardino City Schools, San Bernardino, California
Lambert Gilles	Counselor, La Cumbre Junior High School, Santa Barbara, California
Melvin W. Gipe	Consultant, Bureau of Education Research, State Department, Sacramento, California
Jerry H. Girdner	Dean, Student Personnel, College of the Sequoias, Visalia, California
Clayton M. Gjerde	Professor of Education, San Diego State College, San Diego, California
Phyllis A. Goldman	Psychometrist, Contra Costa College, San Pablo, California
Robert C. Goodridge	Dean of Students, University of Redlands, Redlands, California

Garford G. Gordon	Research Executive, California Teachers Association, San Francisco, California
John C. Gowan	Associate Professor of Education, San Fernando Valley State College, Northridge, California
J. Rollin Grant	Headmaster, Francis W. Parker School, San Diego, California
Robert T. Gray	Dean of Counseling and Testing, San Diego State College, San Diego, California
John S. Greene	Head Counselor, Santa Barbara Senior High School, Santa Barbara, California
Ronald L. Greeson	Pasadena College, Pasadena, California
Vernon L. Gregory	Curriculum Specialist, California State Polytechnic College, Pomona, California
Ace Griffiths	Dean of Students, Reedley College, Reedley, California
Winifred Guild	Associate for Advisory Services, Educational Testing Service, Los Angeles, California
Kay Guiremand	Registrar, Immaculate Heart College, Los Angeles, California
Robert S. Hage	Associate Dean, Guidance, Long Beach State College, Long Beach, California
Barbara Hamilton	Psychometric Intern, Covina Schools, Covina, California
Joseph T. Hanson	Director of Research, California Teachers Association, Los Angeles, California
Wesley Harmon	Associate Dean of Guidance, Chaffey College, Ontario, California
James M. Harris	Assistant Professor of Educational Psychology, Brigham Young University, Provo, Utah
Lucille B. Harris	Supervisor Test-Scoring Department, Orange County Schools, Santa Ana, California
Richard Harsh	Assistant Director, Division of Research and Guidance, Los Angeles County Schools, Los Angeles, California
Dale J. Hart	Counseling Psychologist, Veterans Administration, Los Angeles, California

John S. Helmick	Director, Los Angeles Office, Educational Testing Service, Los Angeles, California
Ralph C. Hickman	Consultant in Guidance, Orange County Schools, Santa Ana, California
Elise Hobden	Admissions Counselor, University of California, Los Angeles, California
Byron M. Holmes	Assistant Dean, Los Angeles City College, Los Angeles, California
Clifford Hunt	Guidance Director, Redondo Beach Elementary Schools, Redondo Beach, California
Lona Ingwerson	Counselor, Glendora High School, Glendora, California
Clyde A. Jack	Psychologist, Chaffey College, Ontario, California
Gladys M. Jewett	Manager, Student Counseling Center, University of California, Los Angeles, California
Berdine J. Jones	Consultant, Research and Guidance, Los Angeles County Schools, Los Angeles, California
Harold W. Kaar	Assistant Superintendent, Guidance and Special Education, Contra Costa County Schools, Martinez, California
David W. Keirsey	Psychologist, Covina Elementary Schools, Covina, California
S. A. Kendrick	Vice President, Examinations and Research, College Entrance Examination Board, New York
Phyllis Kennedy	Testing Supervisor, San Fernando Valley State College, Northridge, California
Robert M. Kimball	Headmaster, Town School, San Francisco, California
Donald J. Kincaid	Supervisor, Guidance and Counseling, Los Angeles City Schools, Los Angeles, California
Mary H. Kirby	Counselor, East Los Angeles Junior College, Los Angeles, California
Dorothy M. Knoell	Consultant in State College Curricula, State Department of Education, Sacramento, California
Theodore Kopp	Registrar, Burbank Senior High School, Burbank, California

David P. Kressen	Director of Testing, Polytechnic School, Pasadena, California
Evelyn La Lanne	Coordinator of Counseling, Huntington Beach High School, Huntington Beach, California
Nadine M. Lambert	Research Consultant, California State Department of Education, Los Angeles State College, Los Angeles, California
Robert E. Lambert	Assistant to the Director, Advisory Services, Educational Testing Service, Los Angeles, California
Lois Langland	Counseling Psychologist, University of California, Student Counseling Center, Los Angeles, California
Walter Lauterbach	Psychologist, Azusa City Schools, Azusa, California
Alexander I. Law	Associate for Advisory Services, Educational Testing Service, Los Angeles, California
Margaret Law	Psychologist, Placentia Unified School District, Placentia, California
Edgar L. Lazier	Associate Director of Admissions, University of California, Los Angeles, California
D. Welty Lefever	Professor of Education, University of Southern California, Los Angeles, California
Audrey Levitt	Director of Guidance and Special Schools, Santa Clara County Schools, San Jose, California
Charles R. Lewin	Director of Counseling and Guidance, Inglewood High School, Inglewood, California
Russel L. Lewis	Dean, Admissions and Guidance, Santa Monica City College, Santa Monica, California
Robert T. Littrell	Test Officer, Long Beach State College, Long Beach, California
Eugenia Loder	Dean, Counseling and Testing, Los Angeles State College, Los Angeles, California
Orral S. Luke	Director of Guidance and Testing, Kern County Union High School and College District, Bakersfield, California
Carol Lundberg	Psychologist, Enterprise School District, Compton, California

Raymond S. Luttrell	Head, Social Science Department, Mark Keppel High School, Alhambra, California
Sister M. Johanna	Registrar, Immaculate Heart High School, Los Angeles, California
Helen McCannon	Senior Counselor, Azusa High School, Azusa, California
Alberta Ruth Magaw	Coordinator, Tests and Guidance, Montebello Senior High School, Montebello, California
Jane L. Main	District Psychologist, Whittier City Schools, Whittier, California
Stuart J. Mandell	Guidance Coordinator, East Whittier City School District, Whittier, California
Arthur Marmaduke	Director of Admissions, Occidental College, Los Angeles, California
F. Grant Marsh	Coordinator, Testing Services, San Francisco State College, San Francisco, California
Glenn C. Martin	Instructor - Counselor, Santa Monica City College, Santa Monica, California
Sister Mary Louise	Dean, Immaculate Heart College, Los Angeles, California
Jane E. Matson	Assistant Professor, Los Angeles State College, Los Angeles, California
Richard Matteson	Instructor, University of Maryland, College Park, Maryland
Leon C. Meeks	Dean, Santa Monica High School, Santa Monica, California
Sister Mercia Louise	Dean of Women, Mount St. Mary's College, Los Angeles, California
Cecil Miller	Registrar, Pasadena College, Pasadena, California
Frederick A. Miller	Director of Testing, Grant Union High School District, Del Paso Heights, California
N. R. Montesano	Pupil Personnel Consultant, San Marcos High School, Santa Barbara, California
Wm. E. Montonna	Coordinator of Counseling, Westminster High School, Huntington Beach, California

George H. Moore	Director of Testing, Biola College, Los Angeles, California
James W. Moore	Executive Secretary, State Scholarship Commission, Sacramento, California
Ivy Mooring	Psychologist, Palos Verdes School District, Rolling Hills, California
Dortha L. Morrison	Secretary, State Scholarship Commission, Sacramento, California
Barbara Morse	Head of Lower School, Westridge School, Pasadena, California
Harold R. Moses	Director, Junior Division, Army-Navy Academy, Carlsbad, California
Elizabeth J. Murphy	Psychometrist, Pasadena City College, Pasadena, California
Ted Neff	Principal, Palos Verdes School District, Rolling Hills, California
James H. Nelson	Assistant Director, Office of Relations with Schools, University of California, Los Angeles, California
Winston Nelson	Principal, Ganesha High School, Pomona, California
Thomas Nesbitt	Director of Testing and Research, City College of San Francisco, San Francisco, California
Leland B. Newcomer	Assistant Superintendent, Covina School District, Covina, California
Esther Grace Nolan	Consultant, Research and Guidance, Los Angeles County Schools, Los Angeles, California
Gwen Norton	Intern, Western Personnel Institute, Pasadena, California
Kenneth Norton	Director, Secondary Curriculum, Riverside City Schools, Riverside, California
Thomas J. O'Connor	Assistant Director of Instruction, Mt. San Antonio Junior College, Pomona, California
Richard E. Olin	Director of Training, 2567th Air Reserve Center, Van Nuys, California

Paul E. Opstad	Counselor, Long Beach State College, Long Beach, California
Margaret L. Orear	Assistant Superintendent, Bellflower Unified School District, Bellflower, California
Jacob S. Orleans	Lecturer in Psychology, University of Nevada (Southern Regional Division), Las Vegas, Nevada
Stanley R. Ostrom	Director of Test Development, California Test Bureau, Los Angeles, California
Mary H. Owen	Administrative Assistant, Advisory Services, Educational Testing Service, Los Angeles, California
Lester E. Park	Principal, Orangewood Junior Academy, Garden Grove, California
Sylvester R. Patrick	Psychometrist, Arcadia High School, Arcadia, California
Howard H. Pattee	Executive Secretary, California Association of Independent Schools, Los Altos, California
W. R. Patterson	Director of Guidance, Arcadia High School, Arcadia, California
Ernest A. Payne	Principal, Chaffey High School, Ontario, California
Douglas B. Pearce	Counselor, East Los Angeles Junior College, Los Angeles, California
Elizabeth A. Pellett	Learning Materials Coordinator, Whittier Union High School District, Whittier, California
R. C. Perry	Professor of Education, University of Southern California, Los Angeles, California
C. E. Petersen	Director of Curriculum, Redwood City School District, Redwood City, California
Lyman K. Peterson	Guidance - Attendance Coordinator, Paramount Unified School District, Paramount, California
Doreen Plaistowe	Head, Test Distribution Department, Educational Testing Service, Los Angeles, California
Frank N. Priester	Head Counselor, Science Department, San Marcos High School, Santa Barbara, California
Edra Pruett	IBM Operator, Orange County Schools, Santa Ana, California

Mabel C. Purl	Director, Research and Testing, Riverside City Schools, Riverside, California
Richard Purviance	Elementary Principal, Riverside City Schools, Riverside, California
Curtis P. Ramsey	Guidance Coordinator, Department of Education, San Diego County Schools Office, San Diego, California
Martin Rappaport	Psychometrist, West Covina School District, West Covina, California
Alfonso Rascon	Student, Loyola University, Los Angeles, California
William K. Reece	Psychometrist, Covina Elementary School District Covina, California
Harold J. Reed	Consultant, Research and Guidance, Los Angeles County Schools, Los Angeles, California
David Reiss	Director of Guidance, Morningside High School, Inglewood, California
Helene M. Ressler	Assistant to the Director (Accounting and Planning), Educational Testing Service, Los Angeles, California
Harlan Reyburn	Director of Secondary Education, Stockton Unified School District, Stockton, California
Sybil Richardson	Consultant, Research and Guidance, Los Angeles County Schools, Los Angeles, California
Joseph J. Richert, Jr.	Dean, Desert Sun School, Idyllwild, California
William V. Rickel	Coordinator of Testing, Anaheim Union High School District, Anaheim, California
John Joseph Risser	Psychologist, Pasadena City College, Pasadena, California
Lester W. Ristow	Consultant, Research and Guidance, Los Angeles County Schools, Los Angeles, California
Mildred Robeck	Assistant Professor of Education, University of California at Santa Barbara, Goleta, California
Marjorie B. Robertson	Administrative Assistant, Hawaii Preparatory Academy, Kamuela, Hawaii
Alvin E. Robinson	Assistant Professor of Education, University of California at Santa Barbara, Goleta, California

James T. Robinson	Mathematics and Science Coordinator, Whittier Union High School District, Whittier, California
Thomas B. Rodgers	Assistant Director, Educational Testing Service, Los Angeles, California
Robert E. K. Rourke	Executive Director, Commission on Mathematics, College Entrance Examination Board, New York
Dorothy Roy	Executive Secretary, Educational Testing Service, Los Angeles, California
Harry C. Rubie	Director of Education, Sweetwater Union High School District, Chula Vista, California
Marie Sander	Coordinator of Guidance, Bellflower Unified School District, Bellflower, California
Judson Sanderson, Jr.	Professor of Mathematics, University of Redlands, Redlands, California
Margaret Schilling	Director of Guidance and Pupil Services, Hayward Union High School District, Hayward, California
Elnora Schmadel	Coordinator, State Gifted Child Study, California State Department of Education, Bellflower, California
Jim Schunert	Professor of Education, San Diego State College, San Diego, California
John B. Scott	Dean of Education, Southern California Bible College, Costa Mesa, California
Inez Sepmeyer	Admissions Counselor, University of California, Los Angeles, California
William Shanner	Director, Professional Service, California Test Bureau, Los Angeles, California
E. Boyd Shannon	Professor of Psychology, Pasadena College, Pasadena, California
Carleton B. Shay	Director of Testing, Santa Monica High School, Santa Monica, California
Eloise Shields	Psychologist, Lawndale School District, Lawndale, California
Laurel Simpson	Counselor, Placentia Unified School District, Placentia, California

William M. Slaichert	Assistant Professor, School of Education, University of Denver, Denver, Colorado
Harry Smallenburg	Director, Division of Research and Guidance, Los Angeles County Schools, Los Angeles, California
Bernice Smith	Head, Registration and Centers Department, Educational Testing Service, Los Angeles, California
Carol E. Smith	Director of Instruction, El Segundo Unified School District, El Segundo, California
John Allan Smith	Assistant Superintendent - Education, Paramount Unified School District, Paramount, California
Marc Jack Smith	Dean of the Faculty, University of Redlands, Redlands, California
Thomas W. Smith	Director, Research and Pupil Personnel Services, Covina School District, Covina, California
W. Holmes Smith	Assistant Director, Student Personnel, El Camino College, El Camino College, California
Faith Smitter	Associate Specialist, Education, University Extension, University of California, Los Angeles, California
James E. Solt	Secondary Coordinator, Fresno County Schools, Fresno, California
Don J. Sorensen	Psychologist, Redondo Beach City School District, Redondo Beach, California
Madeline C. Sorensen	Vice-Principal, Pioneer High School, Whittier, California
Garth Sorenson	Associate Professor, School of Education, University of California, Los Angeles, California
Leroy Spore	Secondary Coordinator, Tulare County Schools, Visalia, California
Doyle J. Stansel	Counselor, Test Officer, California State Polytechnic College, Pomona, California
John S. Stevens	Dean of Counseling, Mt. San Antonio College, Pomona, California
Edwin J. Swineford	Assistant Professor of Education, University of California at Santa Barbara, Goleta, California

Arthur T. Tait	Director of Research, Riverside County Schools, Riverside, California
Edward A. Taylor	Evaluation Supervisor, Alameda County Schools, Hayward, California
Jim Thomas,	Psychometrist, El Monte School District, El Monte, California
Muriel Thomson	Consultant, Research and Guidance, Los Angeles County Schools, Los Angeles, California
Louis P. Thorpe	Professor of Education, University of Southern California, Los Angeles, California
Naoma S. Troxell	Director of Guidance, Orange County Schools, Santa Ana, California
Ralph W. Tyler	Director, Center for Advanced Study in the Behavioral Sciences, Stanford, California
Elizabeth Van Dalsem	Director, Guidance and Research, Sequoia Union High School District, Redwood City, California
Donald E. Walker	Dean of Students, San Fernando Valley State College, Northridge, California
Katharine L. Walker	Assistant Director, Relations with Schools, University of California, Los Angeles, California
Mildred Wallace	Director, Education, Ventura Elementary Schools, Ventura, California
Betty Walthall	Psychometrist, Ranchito School District, Pico-Rivera, California
Geneve Walton	Psychologist, West Covina School District, West Covina, California
Rosalie Waltz	Director of Guidance Services, Santa Monica Unified School District, Santa Monica, California
Harry Wandling	Director of Education, San Luis Obispo County Schools, San Luis Obispo, California
Edwin Wandt	Associate Professor, Los Angeles State College, Los Angeles, California
Beulah Ware	Assistant Director, Research, Long Beach Unified School District, Long Beach, California

Florence Edna Ware	Supervisor of Guidance, Valley-East Elementary District, Los Angeles City Schools, North Hollywood, California
Jane Warters	Lecturer, University of Southern California, Los Angeles, California
Dorothy G. Watson	Supervisor of Guidance, Central District, Los Angeles City Schools, Los Angeles, California
Henry I. Weitzel	Research Director, Pasadena City Schools, Pasadena, California
Risdon J. Westen	Chief, Research Division, Evaluation Directorate, Office of Cadet Registrar, U. S. Air Force Academy, Colorado
Raymond Whort	Head, Science Department, Happy Valley School, Ojai, California
Mildred Wilbar	Vice-Principal, Santa Monica High School, Santa Monica, California
Burton A. Wiley	Assistant Principal, Chaffey High School, Ontario, California
Margaret C. Williams	Psychologist, Little Lake City School District, Santa Fe Springs, California
Claude E. Wilson	Consultant, Research and Guidance, Los Angeles County Schools, California
Jack Wilson	Professor of Mathematics, San Francisco State College, San Francisco, California
Ilah M. Wilstach	Head Counselor, Edgewood High School, Covina, California
Helen Wittmann	Counselor, Artesia School District, Artesia, California
Nathalie Wollin	Director, Children's Country School, Los Gatos, California
John C. Woodward	Test Officer, San Jose State College, San Jose, California
William Wright	Guidance Counselor, Rowland Union School District, La Puente, California
William J. Wright	Director, Curriculum and Instruction, Downey Union High School District, Downey, California

Blanche Wyatt	Mathematics Teacher, Girls' Collegiate School, Claremont, California
David Young	Director of Studies, Happy Valley School, Ojai, California